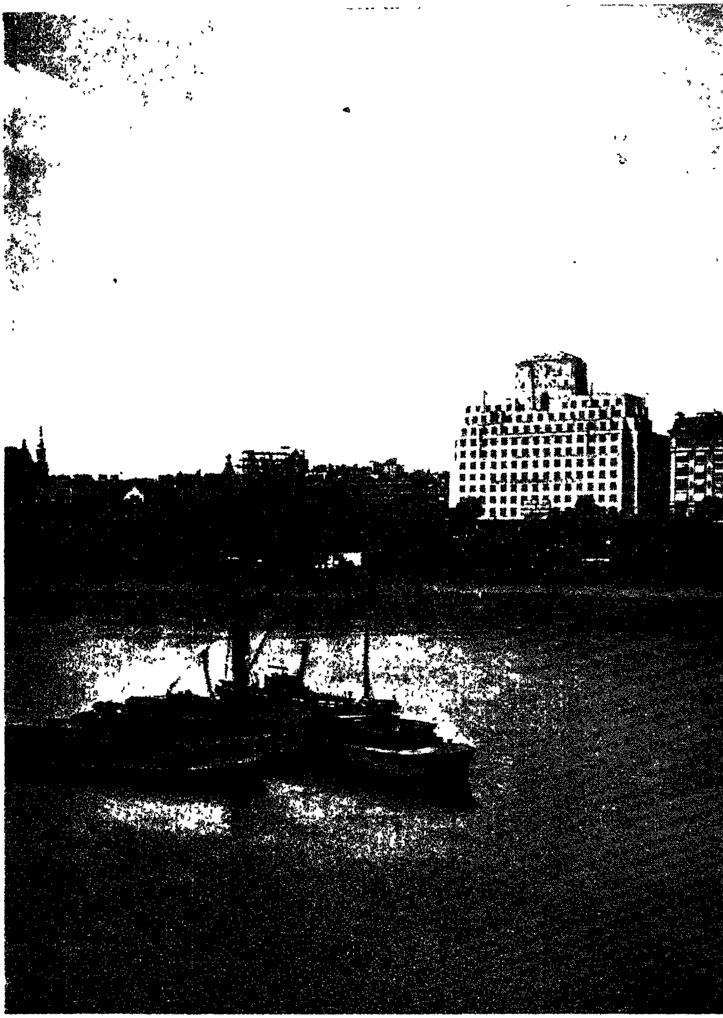

MODERN LONDON

The Shell-Mex Building, completed in 1932-33, is symbolical of the functions and modern development of London. It is the headquarters of an international organisation and replaces the world-famous Hotel Cecil—illustrating the expansion in space of commercial London outside the City. Its neighbour on the right is the Savoy Hotel, on the left is Adelphi Terrace, designed by the Adam Brothers, which has been demolished since the first edition of this book and since this photograph was taken in 1933. On the extreme left is the spire of St. Martin-in-the-Fields, Trafalgar Square. On the Thames Embankment is "Cleopatra's Needle." The coal-barges or lighters taken coal to a riverside power station are very characteristic of the Thames at London; the Thames sailing barges, of which one is shown, are now becoming scarce.

THE BRITISH ISLES

A GEOGRAPHIC AND ECONOMIC SURVEY

BY

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AND

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WITH CONTRIBUTIONS BY THE LATE

LORD STAMP, G.C.B., G.B.E., D.Sc., LL.D., F.B.A.

AND

DORA K. SMEE, M.A., Ph.D.

THIRD EDITION
REVISED

WITH NUMEROUS MAPS AND ILLUSTRATIONS

LONGMANS, GREEN AND CO.
LONDON • NEW YORK • TORONTO

". . . To the hope that one day this country of ours, which we love so much, will find dignity and greatness and peace again."

NOEL COWARD ("Cavalcade")

NOTE TO THE THIRD EDITION

The remaining copies of the second edition of this work were destroyed by the fire which devastated Paternoster Row as a result of enemy action on the night of December 29–30th, 1940. As a matter of extreme urgency we have endeavoured to incorporate in this edition a few corrections and additions which we had previously noted as desirable, but it has not been possible to carry out a systematic revision. Even if the time had been available, circumstances would not have permitted the revision and bringing up to date of the accounts of British industries though it has been possible to refer to the progress up to the outbreak of war and, in the case of agriculture, to indicate some of the more obvious results of war-time policy. Where the phrase pre-War still remains in the text it must be taken to mean pre-1914.

This hasty revision has been carried out while we have been enjoying the hospitality of the University of Cambridge and we should like to take this opportunity of expressing our appreciation of the cordial help which has been accorded us on all sides—especially by the staffs of the School of Geography and the University Library.

L. D. S.
S. H. B.

London School of Economics
at Peterhouse,
Cambridge,
February, 1941.

PREFACE

When I was a boy I was doubtless at certain times—especially during school holidays—a considerable nuisance to my parents. On one such occasion they, with that consummate wisdom which can camouflage a task as a special treat, found me some work to do. I was allowed to "help" in the annual stocktaking at one of the businesses under my father's control. What I discovered then impressed me so vividly that, unconsciously no doubt, I developed a new outlook. For I found that there were many commodities of which I had previously never heard which were obviously in large public demand: others which were familiar objects in my own home were apparently in general disfavour with the public.

Too often, it is to be feared, one grows up with a view of the nation's life which is, it may be unconsciously, biased or at least coloured too vividly by one's own personal experience. The worker in one sphere may have but a very incomplete picture of the life and problems of a fellow-worker in another sphere. It may be that he overemphasises, or perhaps underemphasises, the importance of his own vocation, trade, or, it may be, his whole sphere of life. Yet every one, as a voting citizen, shares the responsibility for the progress of the State and should, therefore, be possessed of a sane outlook based upon balanced knowledge. What, therefore, I have tried to do in this book is to take stock of the natural resources of the British Isles, and show broadly what use has been made of those resources in the past, and to analyse the present position. In particular, attention has been paid to the natural or geographical factors which influence the utilisation of resources, and thus the point of view is that of the economic geographer. A reviewer once said of one of my books that "Dr. Stamp has a passion for facts and a tidy mind." If I plead guilty to the former accusation it is from the firm conviction that facts are the only safe building material, and that they can be used and appreciated by the citizen who is, of necessity, a nation builder at a critical period in history. Throughout the book a number of comparisons between pre-war and post-war years will be found, but I have attempted to emphasise in particular the present position. Rightly or wrongly, it is my own firm belief that this country is, to a considerable extent, still suffering from an insidious and widespread disease—a disease which I have

on other occasions referred to as the "1914 mind." There is still the idea that when the world settles down to "normal" conditions once more those normal conditions, especially in relation to world trade, will in some ways resemble conditions in 1913–14. One hears constant talk of regaining lost coal markets, of the resuscitation of the cotton industry by recapturing its 1913–14 trade—statements which clearly, though perhaps unconsciously, ignore the evolution of the other countries in the world in the war and post-war years. I have not attempted to anticipate the results of the work of the Land Utilisation Survey of Britain, and the emphasis which might be placed on the remarkable abandonment of so much cultivated land in these islands; but I have attempted to deal, in some detail, with the present position of farming, noticing in particular the lines of development which seem at the present day most promising. There are times when, in the writing of this book, one could not help being reminded of the remark of a famous French statesman, "Although actuated by the best intentions, the English are the most disturbing feature in the world because they are always wanting to sell their goods in other people's markets instead of living like gentlemen on their own soil." For again and again one gets a glimpse of vast home resources as yet but little utilised, or capable of much more intense utilisation: our neglected woodlands, our vast moorlands and upland pastures, our limited acreages of orchards and market gardens, the virtual absence of what the American would call truck farms, the still limited number of canning factories and bacon factories are all features which point to the possible use of the resources of the land. But the future is fraught with possibilities of progress, as yet but vaguely indicated, which are suggested by a few such simple words as the grid, hydrogenation, tidal power, rayon, radio, and others which connote modern progress. As the veteran Professor Armstrong wrote recently, we must play the game with our land, it is the only ultimate asset we shall have, as an island people, if and when all else fails us—hence my excuse for a broad survey of our natural resources.

No one could be more conscious of the difficulties of the task that I have attempted than I am, nor can I hope to escape all the sins of commission or omission. The work has been in hand for some four years, and some of the apparently simple sections have involved considerable preparation and research. For example, the coalfield maps took two assistants and myself about three months to prepare. I do not think the work would have been possible at all without the help of many colleagues and friends. In the first place, my colleague and collaborator, Mr. Beaver, has undertaken those chapters bearing his name on the major industries, and the whole book has been prepared in close consultation between us.

Then my co-author and I are greatly indebted to my brother, Sir Josiah Stamp, for contributing a concluding and summary chapter on the National Capital, evaluating from a different standpoint the use which has been made of the country's natural resources.

While we must accept responsibility for the contents of the chapters, we have endeavoured to avoid serious errors and omissions by securing the co-operation of experts in many of the various fields covered. In this way we are greatly indebted, as will be indicated in the separate chapters which follow, to Dr. J. Glasspoole, Secretary of the Royal Meteorological Society, Professor E. J. Salisbury, F.R.S., University College, London, Mr. Ray Bourne, School of Forestry, Oxford, Sir John Russell, F.R.S., Mr. E. V. Jacks, and Mr. H. V. Garner of the Rothamsted Experimental Station, Sir William Larke, Director of the National Federation of Iron and Steel Manufacturers, Mr. J. A. Todd of the Liverpool School of Commerce, Professor H. J. Fleure of the University of Manchester, Mr. M. I. Michaels, Assistant Secretary of the New Survey of London Life and Labour, as well as to many of our colleagues of the London School of Economics and King's College, including Professor Rodwell Jones and Dr. H. Ormsby, Mr. H. L. Beales, Mr. W. T. Stephenson, Dr. S. W. Wooldridge, Dr. H. J. Wood, Mr. W. G. East, Mr. A. C. O'Dell, and Mr. E. C. Willatts. And, finally, the book has been greatly enriched by a special study of the ports and commerce of Ireland by Dr. D. K. Smee of the University of London, Bedford College.

For the preparation of the Index and for help in the collection of statistics and other information, we are indebted to Miss D. M. Fisher, B.A.

At all times correspondence and criticism of the contents of this book will be greatly welcomed. It is desired that the book should be as widely useful as possible, and any improvements which will conduce to this end are anxiously sought. It must, however, be pointed out that space has prevented a treatment of the geography of the country on a basis of regional divisions: the method has been rather to treat the country as a whole. One reason for this is the existence of the volume of essays on Great Britain, edited by Professor A. G. Ogilvie. The inclusion of a comprehensive bibliography was found to be impossible, so we have compromised by including at the end of each chapter a short list of the more important or immediately available sources of information, whilst statements in the text have been supported, wherever it seemed necessary, by reference to appropriate authorities.

L. D. S.

University of London,
London School of Economics,
August, 1933.

CONTENTS

THE BRITISH ISLES

CHAPTER I

THE POSITION OF BRITAIN

No philosophy of British history can be entirely true which does not take account of the facts of the position of Britain. So wrote Sir Halford Mackinder a quarter of a century ago in that book "Britain and the British Seas," which must for ever remain a landmark in the progress of thought in this country, for it marks an important stage in the resurrection from the dead of the forgotten or discredited science of geography—the study of the earth as the home of man and of the inter-relationship between man and his environment. It will be the purpose of this book to examine the natural environment afforded by the British Isles for their human inhabitants; to examine the advantages and the disadvantages of that environment; to analyse the natural resources of value to man which are proper to these islands; to see the use which the inhabitants have made of those resources, and so to lead up to a study of the present position—the capital which has been accumulated in consequence of past exploitation, and the outlook for the future in the utilisation of the resources which remain.

The philosophers of ancient Greece knew well that the earth was a sphere, and "every schoolboy knows" of the experiments of Eratosthenes by which the actual size of the sphere was measured. But the known world of the ancients occupied but a small portion of the surface of the sphere. It centred round the Mediterranean Sea. To the south it was bounded by the Sahara Desert, beyond which there were but legendary lands. On the south-east it extended to the Indian Ocean, to the east as far as Central Asia, beyond which again lay the mysterious land of Cathay known only because of the silks and porcelain brought by traders to Mediterranean Europe. On the north-western margin of the known world lay the islands of Britain. The name "Albion," which is still sometimes applied to the larger of the two islands, perpetuates the point of view of the ancients. The British Isles were approached and explored from the Continent, and it was the white chalk cliffs of Dover, facing as they do the land of Gaul, which suggested a name for the whole country. The Celtic lands of Ireland, Wales,

and Scotland lay on the outermost fringe, so little known that in many of the ancient maps Scotland is represented as an island. Throughout early Christian or Medieval times the marginal or terminal position of the British Isles became accentuated as the scientific conceptions of the ancients became lost during the Dark Ages. The fantastic maps of the medieval monks show Jerusalem as the centre of a flat earth separated by the blue curtain of the sky from the celestial Jerusalem above, but again with the British Isles on the margin and doubtless near the dangerous "edge" of the world.

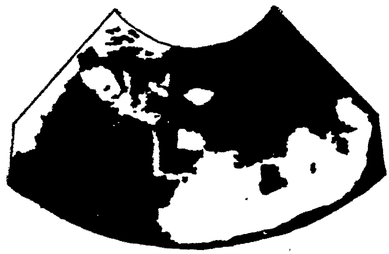


FIG. 1.—Map showing the terminal or marginal position occupied by Britain in the world as known to the ancient Greeks and medieval geographers. (*After Ptolemy.*)

The year 1492 not only marks the discovery of the Americas by Columbus, but it marks the end of the dominance of the countries of the Mediterranean basin; for it released the British Isles from the disadvantage of being on the fringe of world politics and placed London in the centre of the land of the globe, and the British Isles in a dominating position relative to all the world. This re-orientation was not the result of an accidental discovery. Columbus's voyage was based on a firm belief that the earth was a sphere and that it was consequently possible to sail round it. Anyone holding such a view at that time did so not only in opposition to public opinion but also in constant danger of being branded "heretical." One may wonder why the land on the far side of the Atlantic remained so long unknown to Europeans. True, the coasts of Greenland, of Labrador, and of Newfoundland were doubtless known at a much earlier date to the Norwegian fisherman; but however attractive the fisheries might be, the character of the lands was not such as to cause enthusiastic wonder. Flowing southwards, parallel to the coast of Greenland, is a cold current bearing a constant stream of icebergs from the Arctic, and whilst a vessel may sight land, the crossing of this belt of cold water and actual land-

FIG. 2.—The world position of Britain to-day—the centre of the "land hemisphere."

ing on the shores is a matter of extreme difficulty,[1] and climatic conditions are obviously not those to attract such attempts. The navigators of the Mediterranean, a sea which, with its vast extent and its treacherous sudden storms, was no mean school for navigators, knew that when they passed through the Pillars of Hercules, or the Straits of Gibraltar, and turned southwards they were in the belt of the constant North-East Trade Winds, that would always blow them *from* known lands and would allow the venturous mariner no hope of return. Over the north of France and the south of Britain, the winds, though variable, were on the whole from the south-west; but to venture with a sailing vessel of a few tons, which could be victualled only for a limited period, merely to test the theory that one could go outwards by the north-east wind, and at some far distant point find it possible to get in the current of wind which was on the whole south-westerly, required the efforts of a dominating and fearless leader, and Columbus's own sailors nearly lost faith in their leader before land was sighted. Once the discovery had been made no one can fail to be impressed by the rapidity of events which followed—the exploration and the settlement of the American continent—and of the consequent opportunity afforded to those countries of Europe which faced the Atlantic and of which the British Isles formed one. The Mediterranean became a backwater, its commerce and its cultures decayed, and it was not until 1869–70 that the opening of the Suez Canal afforded a resuscitation of its ancient trading glory. By that time the world position of Britain was too firmly established to be shaken by the revived importance of the Mediterranean. Instead, Britain profited by yet another route to the Far East.

It may be thought that in this modern world, with all the improvements in transport and communications which have characterised the last 100 years, position would be of little importance to these islands. Such, however, is far from being the truth. An attempt has been made in Fig. 3 to show facts which can much more readily be appreciated by a glance at a globe. From the thickly populated, industrialised countries of northern Europe to the corresponding area of urban development on the far side of the Atlantic, characterised by the north-eastern United States and by the St. Lawrence Basin of Canada, the shortest route (the Great Circle route) lies across the British Isles. Presuming that the proverbial crow really does take the shortest route, that sagacious bird bound either from New York or from Montreal for any one of some fifteen or sixteen capital cities in Europe would, of necessity, have to pass over the British Isles. Actually, all ocean traffic from the ports of the northern seaboard of Continental Europe bound for North America has to make a detour to escape the British Isles

[1] Greenland was first crossed by a European—Nansen—only in 1882.

and passes down the English Channel. The vessels are not taken out of their way by dropping anchor for a short time at one of the ports on the south coast of England, for example Southampton. A short time ago the importance of constructing a Channel tunnel was once again before the public eye. The scheme is interesting geographically because if the tunnel were completed a British port, such as Liverpool, would almost automatically become the railhead of the whole European system—providing a new quick route for passengers and mails from Europe to America.

Further, the world is rapidly becoming more and more air-minded, and air transport is of necessity bound to develop in the future. When "single-hop" aerial transport across the Atlantic

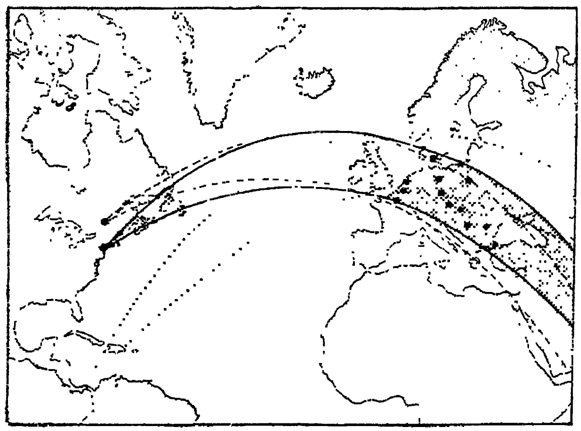


FIG. 3.—Great circle routes from Europe to North America.

Within the two dark lines are the shortest routes between New York and the capitals of European states marked by dots; in each case the shortest route passes through the British Isles. The pecked line shows the same relationship for Montreal; the dotted line for the Panama Canal.

becomes established the line of routes will again, of necessity, pass across the British Isles, and the importance of position is likely to be accentuated. In the present state of development the avoidance of stretches of ocean is desirable, and it is to be observed that from Europe, passing through Britain, the Shetlands, or Faeroe Islands, Iceland, Greenland, and so to Labrador and North America, there is a possible aerial route which avoids the passage of any broad stretch of ocean waters, and where, indeed, there is nowhere a "hop" of more than 300 or 400 miles across the sea, or less than is negotiated by the regular services operating between North and South America. There have, in consequence, been several British Arctic Air Route Expeditions to explore the possibilities of this as an aerial route. The main difficulties encountered have been the meteorological conditions of the Greenland plateau, with

its high winds and sudden squalls and the extreme expense of maintaining landing grounds under such conditions. But again, with the development of really long flights, such difficulties would be obviated, and it is an interesting experiment to take a globe and a piece of string and to notice the shortest distance between Europe and various other parts of the world, and also to calculate the saving of distance—not to say the saving of time—which results by the utilisation of new routes. In any case they all serve to stress the importance of the position of Britain at present and the importance which its position is likely to maintain in the future.

The world relations of Britain reflect in many ways her world position. If, by virtue of situation, the British Isles belong to the Continent of Europe, it is still not too much to say that the British Isles do not really belong to Europe. If the Utopian idea of a United States of Europe be achieved, Britain will scarcely form one of those states. A glance at the foreign news page of one of our important daily papers stresses the orientation of the British view-point towards America and the overseas dominions, rather than towards the Continent of Europe. A few years ago Professor C. B. Fawcett carried out an interesting calculation in studying the direction of foreign mails from the British Isles. Eliminating business correspondence, the mail to America and our overseas dominions was overwhelmingly more important than that to the Continental countries of Europe. Blood ties, linguistic ties, social ties, and economic ties are with the new lands of the world. In still other ways this position of Britain relative to Continental Europe is apparent. A physical map showing the mountainous west of Britain and of Ireland suggests a breakwater protecting the lowlands of Europe, that may even be symbolical of the post-war financial position and of London's still maintained position as the financial centre of the world.

The British Isles lie mainly within the quadrilateral formed by the two lines of longitude 0° and 10° West and the two lines of latitude 50° and 60° North. In latitude the position is roughly comparable to the almost uninhabitable lands of Labrador, to the northern part of British Columbia, and again to the almost uninhabitable lands of Sakhalin and the Kamschatka Peninsula of the coasts of Asia. The British Isles, indeed, enjoy a more favourable climate than any other land so far from the equator. To the north of the islands the sea way is open between the coasts of Iceland and of Norway to the Arctic Ocean, and a constant drift of warm water and of correspondingly warm air pass by these islands into that open channel. We have long been accustomed to refer to this drift of water as the Gulf Stream, and if purists prefer to call it the North Atlantic Drift it does not alter the fact of the significance of the phenomenon. More especially, of course, is the fact significant in

winter, since the shores of the British Isles lie in the winter gulf of warmth. Apart from the advantages of world position, there are numerous advantages from the position of the British Isles more local in character. The existence of a broad Continental Shelf on which the warm waters drifting across the North Atlantic are piled up ensures not only the maximum benefit from these waters in the amelioration of climate, but it accentuates the movement of water by the tides. Thus our ports, always free from ice, are kept free from silt by the strong tidal scour, whilst the shallow seas on the Continental Shelf afford the richest fishing grounds in the world, where variety, caused by the constant movement and mixing of the waters, is the spice of life in the fish world. The English Channel, narrowing eastwards to the Straits of Dover, which are only 21 miles wide at the narrowest part, separates the south of England from France. The North Sea lies between Britain and Holland, Germany, Denmark and Norway.[1] Whatever may be the opinion of travellers crossing the "silver streak," these separating seas are a great advantage to the islands rather than the reverse. But Britain is double-faced. The ports on her southern and eastern shores face the most important and most developed parts of northern Europe. The embouchure of the Thames is opposite that of Europe's most important river, the Rhine. On the other hand, Britain's west-coast ports face the most developed parts of America. This is again symbolical of the intermediate position which Britain occupies, political, financial, and commercial, between America on the one hand and the countries of Europe on the other.

Note

In citing statistics and statements relative to the British Isles the greatest care must be taken to note the area to which reference is made in each specific case. The island of Great Britain consists of three countries—Scotland in the north, Wales in a part of the west, and England occupying the remainder. England, Scotland, and Wales have been joined under one king since 1603; but whilst England and Wales are usually considered together for many purposes, Scotland is distinct. Thus the Board of Agriculture and Fisheries refers to England and Wales but not to Scotland. Statistics and details which are published by the Board refer, therefore, to England and Wales only. Since 1920 Ireland has been divided into Northern Ireland and the Irish Free State (now known as Eire). Northern Ireland has a parliament of its own, but is otherwise closely united to Great Britain. But Eire is an independent dominion of the British Empire and has a president of its own. Thus "United Kingdom" used to mean the United Kingdom of Great Britain and Ireland, now it means the United Kingdom of Great Britain and Northern Ireland. The distinction is important when comparing pre-war and post-war statistics. For many purposes the Isle of Man, with a parliament

[1] Notice the shape of the North Sea. It is relatively narrow at its northern end, and the Shetland Islands lie almost half-way between the north of Scotland and the coast of Norway.

(or House of Keys) of its own, is not part of the United Kingdom. Again, the laws of Great Britain do not apply to the Channel Islands unless such application is specifically laid down and approved by the islands. The following table is given for reference purposes:

	Area (sq. miles)	Population 1921	Population 1931
England	50,874	35,681,019	37,789,738
Wales	7,466	2,205,680	2,158,193
Scotland	30,405	4,882,497	4,842,554
Isle of Man	221	60,284	49,338
Channel Islands	75	90,230	93,061
Northern Ireland	5,237[1]	1,256,561[2]	—
Eire	26,601[1]	2,971,992[2]	2,965,854[3]

[1] Excluding water areas. [2] 1926. [3] 1936.

REFERENCE

H. J. Mackinder: *Britain and the British Seas* Oxford: Clarendon Press, 1907.

CHAPTER II

THE PHYSIOGRAPHIC EVOLUTION OF THE BRITISH ISLES

THE present surface features of the British Isles, as well as their relationship to the features of the neighbouring parts of the Continent of Europe, are the reflection of the long and complicated geological history of the area. Geology has been described as geographical evolution, but, conversely, the existing physical geography of a country is the result of its geological evolution from the dawn of geological time to the present day.

The geologist has divided geological time into four or five great eras and each of those eras into a number of periods. On broad lines the rocks which were laid down in each of those periods can be made to tell the story of the earth's history. Each period was characterised by its own sets of animals and plants, the remains of which have been entombed in the rocks and can be found to-day as fossils. Nor are these episodes in the past history of the earth merely of academic interest. Whether it be in the search for minerals of economic importance or the study of the disposition of those deposits when found in its relation to economic costs of mining; whether it be the study of the rocks of the earth's crust in relationship to the soils which they afford or in relationship to construction on the earth's surface, the studies of the geologist are of fundamental importance. No excuse, therefore, need be made for considering in this chapter the physiographic evolution of the British Isles, by attempting to trace the history of these islands from the earliest times to the present.

The five eras—the Pre-Cambrian (in the rocks of which earliest era no remains of life are commonly found), Primary or Palæozoic, Secondary or Mesozoic, Tertiary or Kainozoic, and, finally, the Quaternary or Modern Period—are the great divisions which the geologist has made in the geological time scale. Subdivisions of these are shown in the diagram, Fig. 4. Further subdivisions are of course made, but those listed are of fundamental importance in that they are in common use for numerous purposes.

Little is known of the geography of Pre-Cambrian times. The rocks of this great era found in the British Isles fall into three main groups:

Era.	Periods or Systems.		Earth Movements.	Igneous Activity.	Characters of Rocks and Soils.
QUATERNARY	RECENT PLEISTOCENE AND ICE AGE				Drift, alluvium and gravel deposits.
TERTIARY OR CAINOZOIC	PLIOCENE		ALPINE	× W. Scotland & Antrim	Crags of East Anglia and some gravels.
	MIOCENE		EARTH	× Volcanics	Almost absent in Britain.
	OLIGOCENE		MOVEMENTS	× Mourne Mts Granite	Sands and clays, where mixed giving good loams; clays give heavy soil, sands very light (London and Hampshire Basins)
	EOCENE				
SECONDARY OR MESOZOIC	CRETACEOUS				Great mass of chalk forms the upper part; sands, sandstones and clays in lower part.
	JURASSIC	OOLITES			Alternations of sandstone or limestone (giving hill ridges) and clays (giving valleys).
		LIAS			
	RHÆTIC				
	TRIASSIC				Upper Keuper rocks give wet [illegible]. Lower Bunter sandstone, poorer sandy soil.
PRIMARY OR PALÆOZOIC	PERMIAN		ARMORICAN EARTH MOVEMENTS	× Cornish × Leinster Granites &c.	[illegible] marl giving fair to good red soil.
	CARBONIFEROUS	COAL MEASURES			Sandstones and shales often very fair soil.
		MILLSTONE GRIT			Grit or sandstone; uplands, poor soil.
		CARBONIFEROUS LIMESTONE			Limestone and sandstone forming uplands except in Ireland.
	DEVONIAN		CALEDONIAN EARTH MOVEMENTS	Many × Volcanic × Rocks, × Newer Scottish Granites	Upper part of Old Red Marl often fertile red soil. Lower part of Old Red Sandstones, flaggy, poor soil.
	SILURIAN				Hard old sedimentary rocks, slates, grit, sandstones, etc. Poor siliceous soils. Igneous rocks stand out as hill masses.
	ORDOVICIAN			× Lavas &c. × Wales & × Lake × District	
	CAMBRIAN				
PRE-CAMBRIAN			CHARNIAN & OTHER MOVEMENTS	× Older × Scottish Granites	Hard metamorphic and crystalline rocks. Poor siliceous soil. Upper part with sandstones.

FIG. 4.—Table of geological time periods.

(*a*) Crystalline or metamorphic rocks, the descriptive name "metamorphic" indicating that they have changed their form: as the result of heat and pressure they have become recrystallised. They are hard, resistant to weathering, and, except where the continuous action of the agents of denudation through untold ages has slowly but surely worn them down almost to sea-level, they tend to form hill masses. It used to be thought that these hard crystalline rocks represented the original crust of the earth. But in one area after another the Pre-Cambrian crystalline rocks have been shown to represent sediments deposited on a solid crust of an already existing world and which were later much altered.

(*b*) Ancient volcanic, and other igneous, rocks of the same period.

(*c*) Sedimentary rocks, such as sandstones and shales, which have suffered less alteration but which are nevertheless older than the most ancient of the rocks which have yielded fossils.

It seems clear that in Pre-Cambrian times there were at least several great periods of folding or earth movement [1] and volcanic activity, and that the earliest rocks were highly folded and ridged up into great mountain chains, before the deposition of those sandstones and other sediments mentioned under (*c*). Thus it is possible, for example in the north-west Highlands of Scotland, to see the way in which the coarse red sandstones known as the Torridonian and which are themselves Pre-Cambrian, rest in hollows amongst the still older mountains of Pre-Cambrian times.

During the first three periods of the Palæozoic era, that is during the Cambrian, the Ordovician, and the Silurian, the earth was inhabited almost exclusively by lowly creatures which had not yet attained the dignity of possessing a backbone. It is possible that during most of these periods a great land mass lay to the north-west of Scotland, and that a broad sea-trough ran across the British Isles. At certain times islands occupied part of Britain and, particularly during the Ordovician, volcanic activity was rife. Some of the volcanoes were submarine and poured out their lavas on the sea floor; others were volcanoes of an explosive type which threw out huge quantities of ashes. Thus we find that the deposits of the Cambrian, the Ordovician, and the Silurian periods are, for the most part, marine sediments, originally clays, silts, sands, and coarser deposits, but inter-bedded with which are found the lavas of contemporary volcanoes and beds of ashes, whilst intruded amongst the sediments are other masses which came up in a molten

[1] One system, developed in some of the small ancient blocks of the Midlands of England, notably in Charnwood Forest, has produced north-west to south-east or "Charnian" folds.

condition from the lower layers of the earth's crust and which solidified before reaching the surface. Most of the old sediments have become hardened. The clays have become hard shales and slates, the silts and sands have become sandstones, quartzites, and other hard rocks, so that again the sediments of these three periods tend to form hill and mountain masses and to occur in what will later be described as the Highland Zone of the British Isles. The various igneous rocks are even more resistant to the agents of weathering than are the sediments, and many of the highest mountains of the British Isles are formed of the ancient lavas which were extruded at this time, familiar examples being Snowdon and Cader Idris in North Wales.

Towards the close of Silurian times occurred one of the great periods of mountain building which from time to time have played an enormous part in the determination of the present surface features of the earth. It was during this great period of earth movements that the Highlands of Scotland and the Southern Uplands were formed, and because of its great importance in Scotland the period of folding and the folds produced are known as Caledonian. The Caledonian system of earth movements in these islands resulted, for the most part, in the formation of a series of mountain chains which ran from south-west to north-east. So characteristic is this direction for the mountains that it is known commonly as the Caledonian trend. This dominant trend is very clear in the mountains of the Highlands of Scotland, in the Southern Uplands and their continuation into Ireland, in the mountains of North Wales, and to a less extent is apparent, but nevertheless important, in the Lake District. The Caledonian earth movements commenced towards the end of the Silurian and they were prolonged into the succeeding Devonian period, and the sea-trough of Silurian times disappeared. Most of the British Isles became a land mass, but between the great ridges of mountains were deep mountain-girt valleys or basins. In these torrential streams from the recently formed mountains deposited great thicknesses of coarse conglomerates, and sandstones. These are the deposits which we know under the famous name of Old Red Sandstone, and it is remarkable that the Old Red Sandstone deposits often occupy hollows even at the present day, particularly in Scotland. It was only over the south of England that there existed contemporaneously a sea, and in this sea were deposited the Devonian rocks—muds, sands, and silts—which form the Devonian Series in Devon, Cornwall, and the adjoining parts of Somerset and are found also over areas in South Wales. In South Wales and the Welsh border they mingle with deposits of Old Red Sandstone type. It may be that the characteristically red colour of the Old Red Sandstone reflects desert conditions in the neighbouring mountains. Not unnaturally

the few fossils which are found in the Old Red Sandstone are of fish (which lived in the transient lakes of the great mountain valleys) and primitive land plants. The enormous thickness of many of the Old Red Sandstone deposits testifies to the rapidity with which the Caledonian mountains were worn down by the agents of atmospheric weathering. Towards the close of the Devonian period the mountains were already but mere remnants of their former selves, and the commencement of the succeeding period—the Carboniferous—was marked by a great invasion by the sea of practically the whole area. The sea flowed into the pre-existing mountain basins, except in the north where there still

FIG. 5.—The geography of the British Isles in Devonian times.

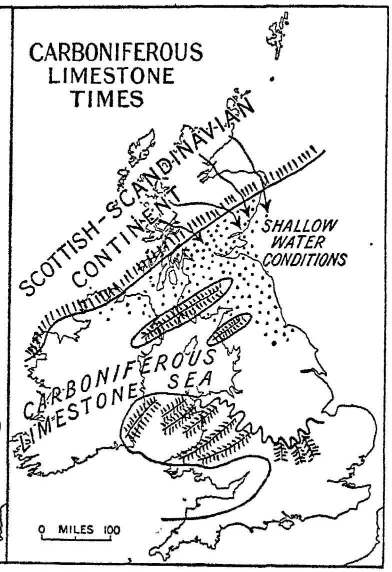


FIG. 6.—The geography of Carboniferous Limestone times.

existed the great continental mass, whose remnants now form the Highlands of Scotland. Over England and Wales and much of Ireland the mountains had been worn down to such an extent that they yielded but little sediment. In the waters of the Carboniferous sea there flourished a wealth of corals and other organisms which are favoured by clear water; and so the deposits laid down were limestones (Carboniferous Limestone). The name once used for Carboniferous Limestone was the Mountain Limestone, indicating the association of this limestone with mountain or upland areas, particularly of the Pennines. But the great continent which extended from Scotland to Scandinavia yielded sediments which prevented the extensive growth of clear-water

organisms in what is now the north of England and the Midland Valley of Scotland. So here one does not see the great thicknesses of Carboniferous Limestone found farther south; instead there are thin beds of limestone in a mass of sandstones and shales. These sandstones and shales represent material brought down by rivers draining from the northern continent, and in the middle of the Carboniferous period a huge river gradually began to overwhelm the British area and to spread its great deposits of sand on top of the limestone which had been just formed. We have really in Britain the formation of an enormous delta, and because of the former use of the sandstone of these deltaic deposits as millstones

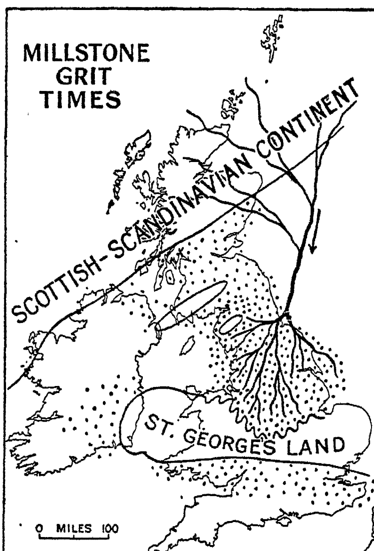


FIG. 7.—The great river delta of Millstone Grit times.

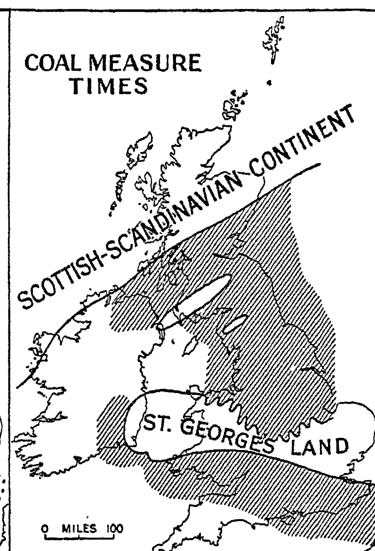


FIG. 8.—The geography of Coal Measure times. The shaded portion shows the area where the coal forests flourished.

the deposits are known as the Millstone Grit. The Millstone Grit delta extended from Scotland right across the Midlands of England as far as an island, known as St. George's Land, which extended from Central Wales through the heart of England.

The great delta which was formed during Millstone Grit times prepared the way for the very widespread growth of swamp forests in the succeeding period of the Coal Measures. The forests of tree ferns and allied plants, whose remains form the coal seams of the present day, flourished in swampy tracts which have been compared by some to the mangrove swamps of the tropics of to-day, and by others to fresh-water swamp forests such as the extensive

Dismal Swamps of the United States in Virginia. Conditions suitable for the growth of such forests were to be found along the margins of the Scottish land mass as early as Carboniferous Limestone or Millstone Grit times, but it was not until the deposition of the great Millstone Grit delta that conditions became suitable over the huge area between the Scottish land mass, where now one finds the Scottish Highlands, and that island that existed across the middle of Britain and to which the name of St. George's Land has been given. There is little doubt that the Coal Measure forests grew over continuous areas from what is now the Scottish border to the Midlands of England, and right across the area where now the Pennine Upland is found. To the south of St. George's Land, in what is now South Wales, the Forest of Dean, the Bristol area, and right across southern England through east Kent into northern France and Belgium there were similar conditions equally suitable for the growth of these forests. It is clear that at intervals the forests were overwhelmed, and indeed entombed, by masses of sand and mud which were brought down by rivers similar in character to those which deposited the Millstone Grit. At other times the slight changes in surface level caused an inrush of the sea, and so in parts of the British Coal Measures there are found thin marine bands. Under most of the British coal seams there are found beds of clay, often with traces of roots, and it would seem that these Coal Measure swamp forests grew in a dark muddy slime, not very different from that in which mangrove swamps grow at the present day. Sometimes this layer of clay underneath the coal seam is of value in that it furnishes fireclay. Occasionally it has become silicified and is important as "ganister." There is little doubt that the land masses of Coal Measure times had been worn down greatly, in fact, almost to sea-level, and towards the close of the period there is evidence that desert conditions prevailed on the neighbouring land masses.

The close of Coal Measure times is marked in many parts of the world by a great series of mountain-building movements, frequently known as the Carbo-Permian earth movements, since the succeeding period is that of the Permian. In the British Isles these movements resulted in four sets of folds :

(1) In the north and north-west of the islands the Carbo-Permian movements resulted in the accentuation of pre-existing folds which had been formed by the Caledonian earth movements.

(2) In such areas as central Wales new folds were formed, broadly speaking parallel to the pre-existing Caledonian folds, that is with a trend from south-west to north-east. The great anticline of the Vale of Towy in Central Wales is a good example.

(3) The most characteristic folds, however, of the Carbo-Permian earth movements are those which have an east and west trend and which are best exemplified in the folding of South Wales and the formation of the South Wales coal basin. The highly complex folds with their axes roughly from east to west which are found in Devon and Cornwall are also of this period, and there they were accompanied by the intrusion of vast masses of granite. On the other side of the Channel the east-west folds of Brittany are of the same age. Brittany, or "Armorica," shows the folds of the Carbo-Permian earth movements so well that they are known as the Armorican earth movements or, alternately, as the Hercynian, from the Harz mountains of Germany.

(4) In other parts of England north-south folds characterise this period and there is little doubt that the general uplift of the Pennines which resulted in the separation of the Coal Measures into an eastern and a western series of basins originated at this time. Another north-south fold typically Carbo-Permian is the line of the Malvern Hills, which now forms the eastern limit of the massif of ancient rocks making up Wales.

As a result of these great earth movements, at the commencement of Permian times Britain was occupied by an important series of mountains, between which there were deep mountain-girt desert basins—and naturally the earliest Permian deposits are usually coarse breccias which are of the nature of screes from the newly formed mountains. Beds of coarse conglomerate and boulders, laid down by torrential streams, are also found. There is one very well-known Permian basin containing rocks of this character, and that is the one which occurs in the south-west, over the eastern parts of what is now the county of Devonshire and the neighbouring parts of Somerset. A great sea, or possibly salt-water lake, comparable to the Caspian at the present day, covered much of Germany. It may, or may not, have been continuous with the main ocean which lay to the south of Europe. This German sea stretched across the North Sea and its western shores were to be found in northern England. After the early coarse deposits the well-known Magnesian Limestone was laid down in the north of England and is found in its best development in Durham and Yorkshire. The waters of the Magnesian Sea seem to have found their way round the southern edge and perhaps across the north of the newly formed Pennines, and attenuated remnants of the Magnesian Limestone are therefore found on the western side of the Pennines. There is little doubt that the land surrounding these areas was under desert-like conditions; most of the sandstones and marls of Permian age are red; many of them

contain grains of sand worn smooth by wind action. The Permian deposits thus form the lower part of what the older geologists described as the New Red Sandstone. This name was not ill-chosen, since the conditions of deposition of the beds must have closely resembled those of the Old Red Sandstone.

Although the Permian is the youngest of the Primary or Palæozoic systems, there is little break in England between the Permian deposits and those of the succeeding Trias, the oldest of the Secondary or Mesozoic. The Trias takes its name from the three-fold division which is possible in the rocks of this series in most parts of northern Europe into Bunter, Muschelkalk, and

FIG. 9.—The seas and salt lakes of Permian times after the Carbo-Permian earth-building movements.

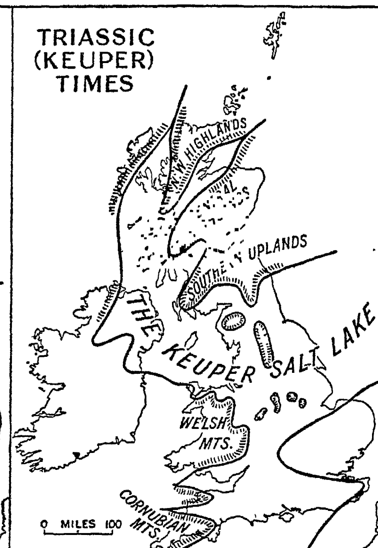


FIG. 10.—The geography of Keuper times.

Keuper. The coarse red sandstones and pebble beds of the Bunter period were laid down in roughly the same areas as the Permian deposits. Like the Magnesian Limestone, the Muschelkalk of Germany and much of Europe was laid down in an inland sea, doubtless a salt-water sea, which, like the Magnesian Limestone sea stretched from Germany across towards England. The Muschelkalk itself as a limestone is, however, absent from England and here the Bunter Sandstones are succeeded by a considerable thickness of Red Marls (Keuper) which were clearly laid down in a shallow basin surrounded by desert country. At intervals this basin was dry, for one finds deposits of salt and gypsum representing salts that were deposited when the shallow basins dried up.

Many of the deposits are ripple-marked; others show "pittings" due to rain storms on the scarcely dry mud. This was an age when giant reptiles first began to be important and the remains of some of them are entombed in the Triassic deposits. Some of the masses of older rocks—the remnants of the Carbo-Permian Mountains—stood up as islands in the Triassic salt lake or sea of the Midlands of England. Examples are preserved to us to-day in the Wrekin, the Lickey Hills, and the hills of Charnwood Forest, so that one finds the red Keuper deposits wrapping round the margins of the ancient rocks. It is the red Keuper Marls which are in the main responsible for the red soils so common in the Midlands of England. The Marls give rise to a soil which is rich, though tending to be waterlogged, but fertile for agricultural purposes if well drained.

The next phase in the physiographic evolution of the British Isles began with the inruption of a sea into the old Triassic basins. Many of the creatures living in the Triassic Sea, such as fishes, were killed off by this sudden incursion of marine waters, whilst organisms which were brought in by the marine waters found themselves unable to survive under the new conditions. Hence it is not surprising to find the earliest deposits of the Rhætic, as the succeeding period is called, consist frequently of "bone beds," built up entirely of the remains of fishes and of reptiles. But in time the sea covered the whole area of the Triassic basins and even overstepped them on to the neighbouring land masses. By this time the land masses were worn down so that the material they yielded was more often of the nature of fine sands and muds, rather than coarse deposits. Conditions favoured the development of certain types of limestone. The Rhætic in this country seems to have been of very short duration and to have left but a thin series of deposits, but the important Jurassic period which succeeds it is represented by a great series of beds which can be divided into three great groups. The Lower Jurassic deposits were the Liassic deposits and are mainly of clay or mud, argillaceous limestones, and occasional sands. In the water of the Jurassic seas enormous numbers of the well-known ammonites flourished, and these are really the dominant fossils of the period. Although there were no great earth-building movements during the Jurassic period, there were doubtless small folding movements; and the deposits of the Middle Jurassic comprise limestones, sandstones, and clays laid down in the tranquil waters of basins more or less cut off from one another.[1] The conditions were particularly suitable for the accumulation of the well-known Oolitic Limestones, and the famous freestones of Bath belong to this period. In the Upper Jurassic, on the

[1] This accounts for the discontinuous character of the scarps formed by the harder beds (see p. 46).

other hand. clays and sands again predominate over the calcareous deposits though the famous Portland stone is of this age. The difference between the soft and easily eroded clays and the harder beds by which they are separated has been a factor of the utmost importance in determining the physiography of the present day south-east of England. Towards the close of the Jurassic period the sea retreated to the north-east, whilst the extreme south-east of England was covered by a great lake, the Wealden Lake, which stretched across what is now the English Channel into France. In this Wealden Lake were laid down deposits of sand and clay, such as the Hastings Sand and the succeeding Weald Clay found at the present day in the heart of the Weald of Kent, Surrey, and Sussex. Around this Wealden Lake lived enormous numbers of giant reptiles such as Iguanodons, whose remains are found in the lake deposits. In the seas which still covered the north-east of England were deposited various beds, including the Speeton Clay of Yorkshire.

Just as the Triassic Lake basins were later invaded by Rhætic seas, so the Wealden Lake basin and the northern marine area were afterwards invaded by the sea of the earlier Cretaceous period. Naturally the earlier deposits were sands and muds, but there had been no extensive earth-building movements affecting Britain since Carbo-Permian times, so that the land surrounding the invading Cretaceous seas were low and yielded but little sediment. There is evidence that on these lands a desert type of climate prevailed. After the formation of the Greensand and Gault Clay deposits the waters of the Cretaceous seas became deeper and were extremely clear. The conditions thus favoured the deposition of one of the most famous of all the deposits found in the British Isles, that remarkably pure white limestone which we know as Chalk. It used to be thought that the Chalk was laid down in deep water under conditions comparable to those prevailing in the open Atlantic Ocean where white " oozes " are being formed at the present day, but it is now believed that the Chalk sea was not necessarily a deep sea, but merely one in which the water was clear owing to the absence of sediment brought from the land. The Chalk itself consists of the remains of innumerable multitudes of tiny organisms, particularly of foraminifera. The exact limits of the Chalk sea in Britain are not easy to determine. It is believed by many that the peneplanation or the smoothing of the mountains of Wales, and possibly even of parts of the Highlands of Scotland, is due to the action of the waves of the Chalk sea.

The Cretaceous is the youngest of the periods of the great Mesozoic or Secondary era. Although in Britain there is comparatively little discordance between the bedding-planes of the Chalk and of the succeeding deposits there is a great change of

character between the two. There was actually a considerable lapse of geological time between the deposition from highest Chalk and the succeeding beds. The earliest of the Tertiary deposits in Britain are the Eocene, and with this period Britain commenced to assume some of the topographical features which are so familiar at the present day. Most of Britain seems to have risen so as to form a great land mass and only the south-east of the country was covered by a sea. Into this sea there emptied one or more great rivers coming from the west from a continental mass which is now beneath the waves of the Atlantic Ocean. The rivers laid down sands and other deposits of predominantly continental origin in

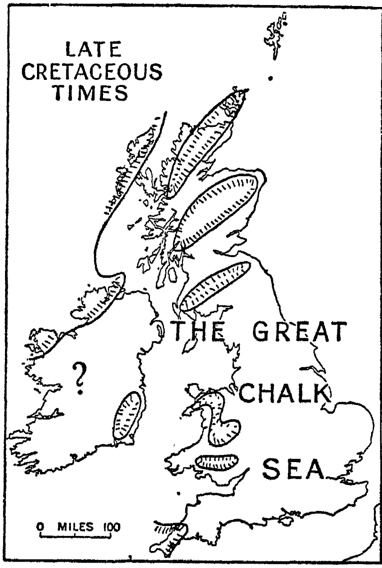


FIG. 11.—Map showing the area *probably* covered by the Chalk Sea.

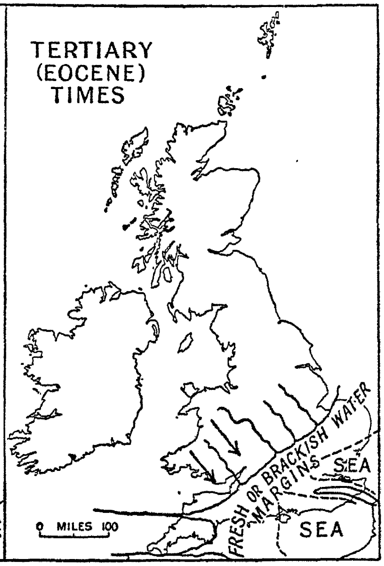


FIG. 12.—The geography of Eocene times.

the western parts of what we call the Hampshire and London Basins, whilst towards the east of these same basins there were being deposited clays or muds containing marine fossils. There is on the whole an alternating succession of deposits of marine and continental origin which marks the various backward and forward movements of the marine waters of the Eocene sea.[1] The same sea covered the well-known Paris Basin in the northern part of France as well as considerable tracts in Belgium and Holland. It was during the Eocene period that there occurred some of the earlier earth tremors which were gradually to increase in strength

[1] Economically this is of the utmost importance because of the variety of soils and consequent land utilisation which result.

and to culminate in those earth-building movements which were the most important of all in determining the present physiography of the globe—the Alpine earth movements. It seems likely that the Wealden dome in south-eastern England commenced to rise during the Eocene period.

The Oligocene period, which succeeds the Eocene, has left but little trace in Britain. If there were Oligocene deposits laid down in the London Basin they have been removed by denudation and Oligocene deposits are almost restricted in this country to the Hampshire Basin. Towards the close of the Oligocene and during

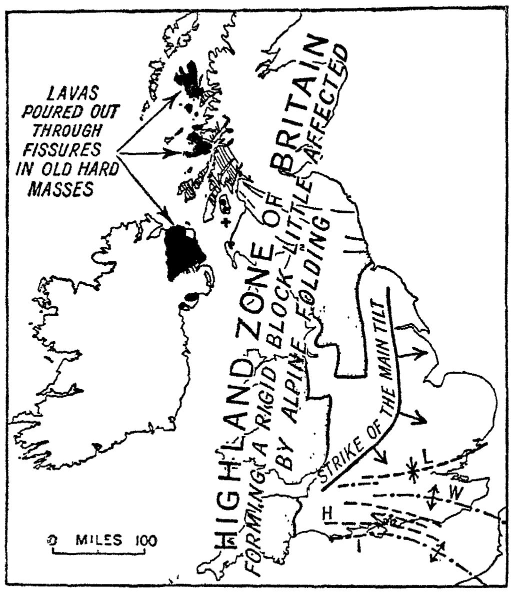


FIG. 13.—Map of the British Isles showing the effects of the Alpine earth movements. The arrows show the dips of the rocks. The fine black lines in the north of England and in Scotland are dykes of igneous rock of the same age filling cracks.

the succeeding Miocene period the great Alpine storm broke. This great period of earth-building movements formed the Alps, the Carpathians, and many of the other great mountain chains of the world. The British Isles were comparatively little affected, since earlier folding movements had exerted their full influence in the north and the north-west of the country and resulted in the formation there of great stable blocks too rigid to be further folded by the earth-building movements so paramount in central Europe, and were at the same time too distant from the main seat of the Alpine storms. It is to be expected that the southern parts of England would be the areas most affected by the Alpine move-

ments; that is actually the case. The folds, for example, which run across the Isle of Purbeck and the Isle of Wight are of this age. The main folding of the Weald is also of the same date. Whilst the ancient rocks of the north of the British Isles were not folded they were rent and torn, and through some of the fractures burst enormous flows of molten rock giving rise to the lava plateaus of

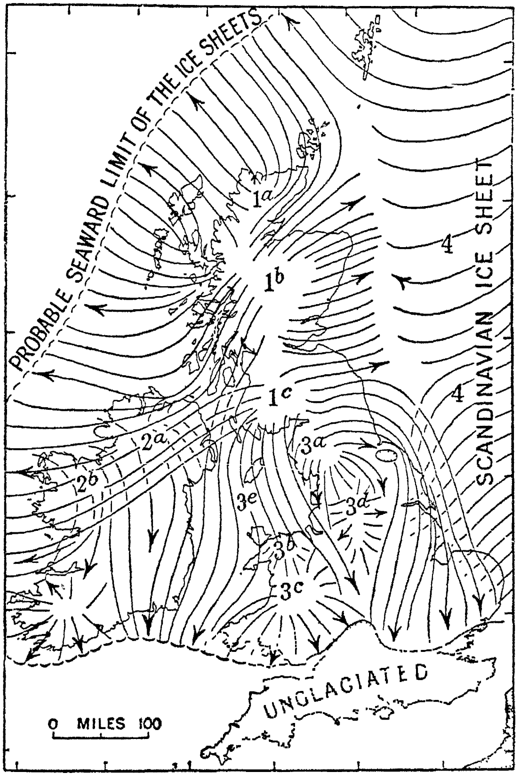


FIG. 14.—The great Ice Age in Britain.

The arrows show the direction of movement of the ice sheets. The local ice caps are: 1a, North-West Highlands; 1b, [illegible]; 1c, Southern Uplands; 2a and 2b, Northern Ireland; 3a, Lake District; 3b, North Wales; 3c, Central Wales; 3d, Southern Pennines; 3e, Irish Sea.

Antrim in Northern Ireland and of many parts of western Scotland, whilst some of the great granitic intrusions, such as the granite mass of the Mourne Mountains in Ireland and some in Scotland, belong to the same period. The succeeding Pliocene period saw Britain taking on very much the form that it has at the present day. The Pliocene sea lingered in what is now the London Basin and later retreated farther north and occupied the position of what is now the North Sea, so that Pliocene deposits in this country are

restricted, broadly speaking, to the London Basin and to East Anglia.

There was still to come, however, an episode in the geological history of these islands which has left its mark in nearly all places; and that was the great Ice Age. At the height of the Glacial Period the greater part of the British Isles was covered with ice sheets. Some of these were of local origin and had their centres in such upland areas as the Highlands of Scotland, the Southern Uplands or the mountains of Ireland, whilst other parts of the British Isles, particularly the east, were affected by the enormous ice sheet which crossed the North Sea from the main centre of the

[*Photo: L. D. Stamp.*

FIG. 15.—Glen Etive, Western Scotland—a typical U-shaped glaciated valley in the Highlands, showing a complete absence of spurs.

Scandinavian mountains. The southern limit of the ice sheets in Britain ran roughly along the present day line of the Thames, so that Britain south of the Thames and of the Bristol Channel was not actually covered by the ice sheet. The Ice Age is of enormous importance to the geographer because of the way in which it moulded the surface of the country and left behind it various superficial deposits which are frequently of much greater importance in determining the character of surface utilisation than are the underlying solid deposits to which the geologist pays greatest attention. Thus the ordinary geological map of the British Isles is really of comparatively little use to the geographer in his attempt to interpret the effect of soil on human activities and as a factor in

the human environment. It is of utmost importance that he should consider what the geologist calls the "drift" map, the map which shows not only the solid rocks underneath but the superficial deposits, many of which are directly or indirectly connected with the great Ice Age. In general it may be said that the great Ice Age had at least the following effects:

(1) The ice removed much of the soil which must previously have been formed in the mountainous areas and has rendered huge tracts of the Highlands of Scotland, for example, almost devoid of soil and therefore comparatively useless for agricultural purposes. The older rocks are exposed at the surface and have been smoothed by ice action, and one sees in the rounded outlines of the topography of the Highlands some of the results of the work of ice. Tongues of ice scooped out pre-existing valleys and smoothed the sides and gave the characteristic U-shaped valleys, devoid of soils, which one finds throughout the Highlands and, indeed, in many parts of northern England and Wales and of Ireland.

(2) Over the low-lying areas glacial deposits were laid down. Some of these consist of coarse sands and even of boulders of morainic character. Elsewhere there are boulder clays—stiff clays full of boulders of various rocks. Or again, there are outwash fans of gravel and sand which were laid down by torrential waters caused by the melting of the glaciers. In the fourth place, some of the finer glacial deposits were redistributed by wind, and whilst the climate of England seems to have been too humid for the formation of vast quantities of loess, which are found in regions where conditions south of the ice masses were drier, the brick earth of England has many of the characters of loess, and is really loess deposited under more humid conditions or under water. These brick-earths are essentially characteristic of the south of the country.

(3) Then the glaciers profoundly altered the drainage of the British Isles and there are innumerable examples of pre-existing drainage which has been affected by the Ice Age.

Since the retreat of the ice sheets from the British Isles there have been several fluctuations in level. Evidences of these fluctuations in level are found in the raised beaches which occur in many places along the coasts, whilst movements of the opposite character are evidenced by submerged forests. Then, again, one must always remember that there has been a progressive change from the extreme cold of the great Ice Age to the climatic conditions which are found at the present day, though the change may have been interrupted by cyclic fluctuations. The spread of the present vegetation into these islands must have been governed by the

changing climatic conditions; doubtless, very considerable portions of the pre-glacial flora managed to persist in the south of the country and formed the nucleus for the reclothing of the British Isles.

The evolution of the rivers and drainage system of Britain will be separately considered; but it should be borne in mind here that there was a drainage system in existence prior to the formation

[*Photo: H.M. Ordnance Survey.*

FIG. 16.—Aerial view of part of the Shetland Islands, showing a glaciated land surface drowned by the sea.

of the ice sheets of the great Ice Age, and that this earlier drainage system was profoundly affected by ice action, and that the present river system of these islands reflects in most cases the result of glacial interference.

References.—The reader will find the evolution of the present geography of the British Isles treated along these lines in L. D. Stamp's *Introduction to Stratigraphy* (Thomas Murby & Co., London, Second Edition 1934). The same subject is elaborated in greater detail in L. J. Wills' *Physiographic Evolution of Britain* (Edward Arnold, 1929). In both these works full references will be found.

CHAPTER III

THE PHYSIOGRAPHY OF THE BRITISH ISLES

In the last chapter, by considering the changes in the distribution of land and water over successive geological periods, we have traced the evolution of the physiography of these islands. In the present chapter we must analyse the physiography as it is at the present day. Leaving on one side for the moment the island of Ireland, the island of Britain is broadly divisible into two parts : a Highland Zone on the north and west, a Lowland Zone on the south and east. It is possible to suggest more than one line which may be used to separate these two divisions, but the most satisfactory seems to be that used in Fig. 17 and elsewhere in this book (see Chapter XXV) and which cuts across the country, following a somewhat irregular course, from the mouth of the River Exe in the south-west to near the mouth of the River Tees in the north-east. It is roughly the line separating the outcrop of the old Palæozoic rocks on the one hand and the younger Mesozoic and Tertiary rocks on the other. To the north and west of the line lie the remnants of the great mountain chains which were built up by successive earth-building movements of Pre-Cambrian, Siluro-Devonian, and Carbo-Permian times. The mountains are, for the most part, but remnants of their former mighty selves, but they still comprise the major mountain and hill masses of Britain. Generally the most ancient masses are those which occur, as in the case of the Highlands of Scotland, farthest to the north-west. Naturally the margins of the ancient rocks are not infrequently covered by strata of later ages.

FIG. 17.—The Highland and Lowland Zones of Britain.

To the south and east of the line one finds first the broad plains or low-lying plateaus, built up mainly of Triassic rocks, which constitute the Midlands of England. Not infrequently small remnants of the ancient mountains stand up as islands in the

midst of these plains of younger rocks. Farther southwards and eastwards the Midland plains give place to what may be called, in the broadest possible sense, the scarplands of England. Indeed, it is possible to draw another line across England, again somewhat irregularly, from the Dorset coast to the north Yorkshire coast. To the south and east of this line lie low ridges, separated by shallow valleys, which mark respectively the outcrop of the harder or more resistant, and softer, or less resistant beds respectively of the geological sequence from the early Jurassic onwards. Like the Triassic rocks of the Midlands, these rocks rest upon an ancient platform which lies buried beneath them at a greater or less depth. Sometimes, as for example under London, the ancient platform is within a thousand feet of the surface. At other times the Palæozoic platform lies at such a depth that the full thickness of the overlying beds has never been penetrated by the boring tools of the well-engineer. The Jurassic and later rocks have themselves been gently tilted, usually towards the south-east, by the Alpine system of earth movements; but it is only in the extreme south that there are signs of what might be called severe folding.

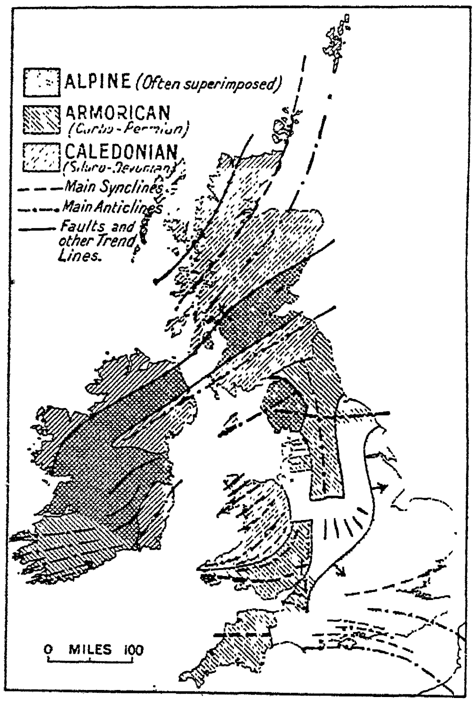


Fig. 18.—Morphological map of the British Isles, showing the spheres of influence of the main folding movements.

For the purposes of a preliminary account we may distinguish in Britain the broad physiographic and structural units described in the following pages.

A. THE HIGHLAND ZONE

(1) **The Highlands of Scotland.**—The Highlands of Scotland are built up for the most part of great masses of ancient metamorphic or crystalline rocks—gneiss, schists, slates, and quartzites.

Some of the folding doubtless took place in Pre-Cambrian times, and it would seem that some of the great intrusions of granite and of other rocks are of the same date. The great period of earth movements which determined the major structures of the Scottish Highlands was, however, the Caledonian, or Siluro-Devonian. These movements gave rise to great mountain chains with a general trend from south-west to north-east, and this is still the dominant "grain" of the country. Between the great mountain chains were the deep basins in which the deposits of the Old Red Sandstone were laid down. Much of the Highlands of Scotland has probably remained land from those very remote ages to the present day, and consequently sub-aerial denudation has gone on almost continuously, culminating with the work of the great ice caps which covered Scotland during the last glacial epoch. As a result, the Highlands of Scotland of to-day no longer present the highly accidented scenery of the younger mountain belts of the world, but rather the rounded outlines which betoken the results of æons of sub-aerial denudation and the work of ice. ✓ On the whole, then, the Highlands form an irregularly surfaced plateau with its greatest elevation along the western margin, sloping on the whole towards the east. The plateau surface has in general an average elevation of between 2,000 and 3,000 feet; some of the higher points often marking the outcrops of granite, of both Pre-Cambrian and Siluro-Devonian ages. The highest points may reach over 4,000 feet, and included amongst them is Ben Nevis, the highest mountain in the British Isles, of 4,400 feet. The Scottish Highlands are divided into the North-West Highlands and the Central Highlands or Grampians by the great cleft of Glen More. The North-West Highlands are by far the more rugged and the grander, and meet the Atlantic Ocean in the intricate fiorded and island-bounded coast of western Scotland. It seems possible that the Alpine earth movements, being unable to fold the old stable block, tended to fracture it instead, and the belts of crushed rock which were formed along the fractures have been more easily excavated by rivers and by ice, and by the waves of the ocean, thus giving rise to the fiords with their remarkable rectangular bends.[1] Through some of the major cracks, too, igneous rocks of Tertiary age have welled up and give rise to the marked lava plateaus of Skye and some other parts of the western coast of Scotland, comparable in character to those found in Iceland. The Old Red Sandstone, originally deposited in valleys, still

[1] The system of major cracks developed along the western coasts of Scotland may be due to pressure exerted from below by masses of molten rock attempting to find an outlet. Just as when one presses with the point of a stick on a sheet of ice covering a pond, or when a stone is thrown through a window, both concentric and radial cracks would be developed, and it would seem that this explains the varied directions followed by the fiords and valleys of the area. See J. W. Gregory, "The Origin and Nature of Fiords"; and J. W. Gregory, "The Scottish Lochs and their Origin," *Proc. R. Phil. Soc. Glasgow*, XLV, 1914, 183–196.

tends to occur in valley or lowland situations, but the more resistant rocks of the period may cover considerable stretches, as they do over Caithness.

The ancient rocks of the Highlands on the whole give rise to a poor type of soil, whilst much of the soil which must previously have been formed has been swept away from most of the higher areas by the ice sheets of the glacial epoch. The tracts occurring on the Old Red Sandstone are, on the whole, more fertile. The same is true of the lower eastern margins of the ancient rocks themselves, as for example in the area known as the Buchan Plateau. Geographically, the eastern margins, whether they are on the ancient rocks or on Old Red Sandstone, are somewhat distinct from the main mass of the Highlands and are frequently considered as a

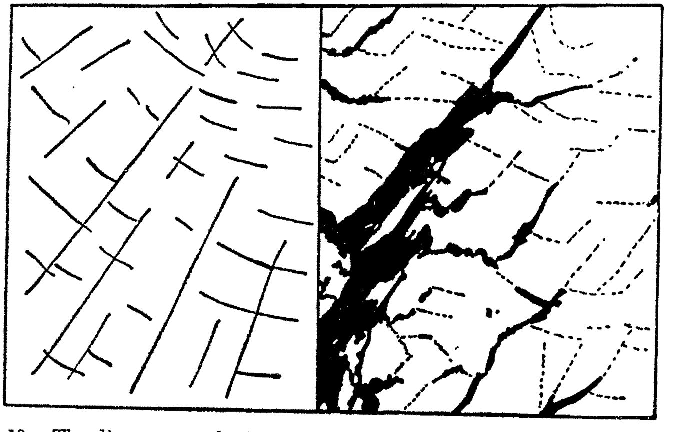
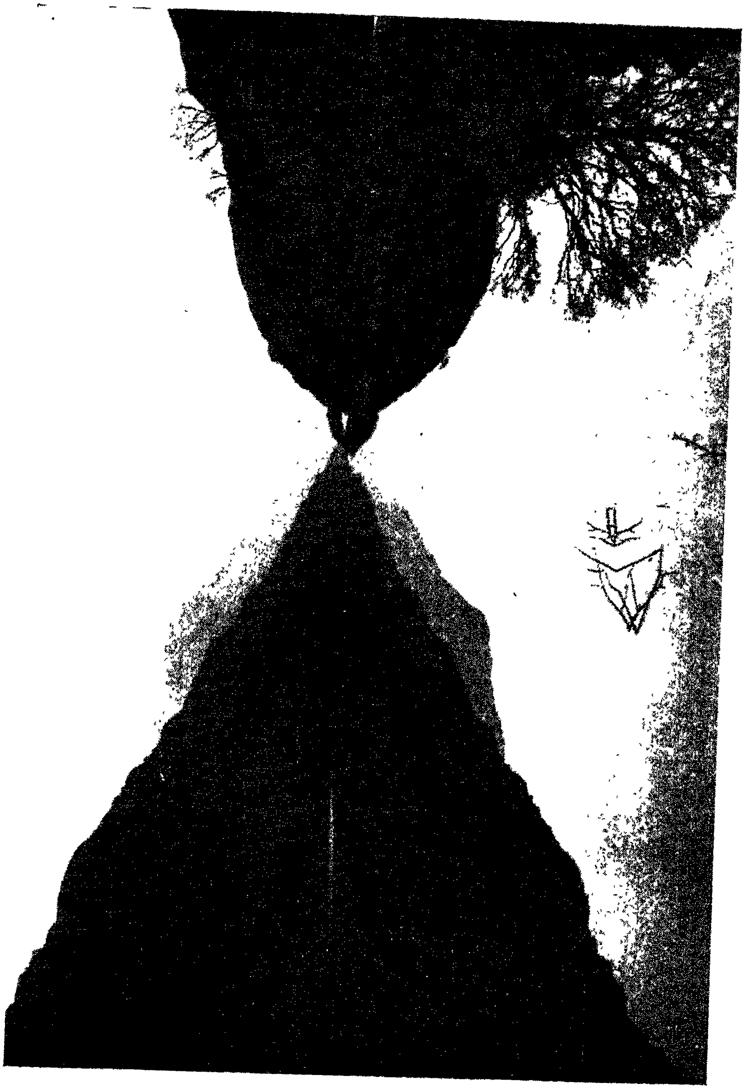


FIG. 19.—The diagram on the left shows cracks which would be developed in a rigid block by pressure from below at a point near the north-east corner. On the right is shown a part of the fiord coast of Western Scotland—water in black, main valleys dotted.

separate region under the title of North-Eastern Scotland. It should be noted that the Orkney Islands form a detached portion of this area, whilst the Shetland Islands, farther north, resemble more closely the central part of the Highlands themselves. The southern limit of the Highlands of Scotland is remarkably well defined by the great Highland boundary fault, actually a succession of faults, which runs across the country with a Caledonian trend, from the mouth of the Clyde to the east coast in the neighbourhood of Stonehaven. The faults seem to have been initiated at the same time as the Caledonian earth movements, but intermittent movements along them have undoubtedly occurred from that time until the present.

(2) **The Southern Uplands.**—The Southern Uplands consist of the denuded remains of a great mountain chain of Siluro-Devonian



[Photo: L. D. Stamp.

FIG. 20.—Loch Eck, Argyllshire.

age and which runs across the south of Scotland from the south-west to the north-east, that is with a characteristically Caledonian trend. There is, however, a marked difference between the Southern Uplands and the Highlands, in that the rocks of which the Southern Uplands consist are sediments, mainly of Ordovician and Silurian age, very highly folded. In the south-west, particularly in Galloway, there are large granitic intrusions, but ancient metamorphic rocks, such as those constituting the greater part of the Highlands, are absent. Consequently all the higher parts of the Southern Uplands are formed of moorland country with rounded outlines, passing on lower ground in the east, particularly in the Tweed basin, to quiet rolling pastoral, and often well-wooded country. In the south-west, cutting across the main mass of the Southern Uplands, are the well-known dales. These dales are comparatively straight clefts running from north-north-west to south-south-east and afford important routeways. Fringing the Southern Uplands, along the shores of the Irish Sea, are stretches of

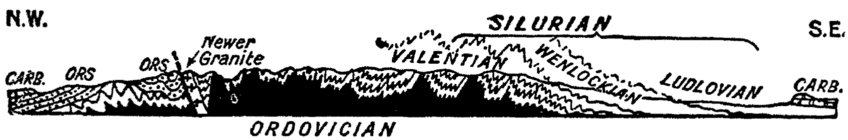


FIG. 21.—Section across the Southern Uplands.

O.R.S. = Old Red Sandstone; Carb. = Carboniferous.

low ground, occupied by smiling, well-watered pasture. The northern limit of the Southern Uplands is formed by a great zone of faulting, comparable in character to the fault-line which bounds the Highlands, though not giving rise to such a marked feature.

(3) **The Central Lowlands, or Midland Valley, of Scotland.**—Lying between the Highlands on the north and the Southern Uplands on the south is the great rift valley which forms central Scotland. Initiated by the Caledonian earth movements it was a basin of deposition of the Old Red Sandstone, and was later occupied by a shallow arm of the Carboniferous sea, so shallow that at an early stage it was suitable for the growth of the swamp forests which have left their traces at the present day in seams of coal. At the same period volcanic activity was rife, and as a general result at the present day neither the topography nor the geology of the Midland Valley of Scotland can be described as simple. It is only in the broadest possible sense a valley. It is possible to distinguish a northern fringing corridor or broad valley, then a line of volcanic hills, then the central lowlands wherein lie the great Lanarkshire or Central Coalfields and the Midlothian or Fifeshire Coalfield, then a line of hills along the south and an ill-defined valley separating them

in turn from the Southern Uplands. These sub-divisions of the valley and their correlation with the geology may be seen in Figs. 22 and 23.

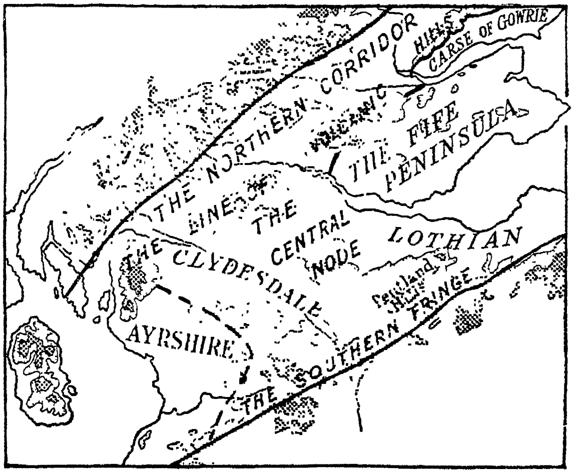


FIG. 22.—Sub-regions of the Midland Valley.

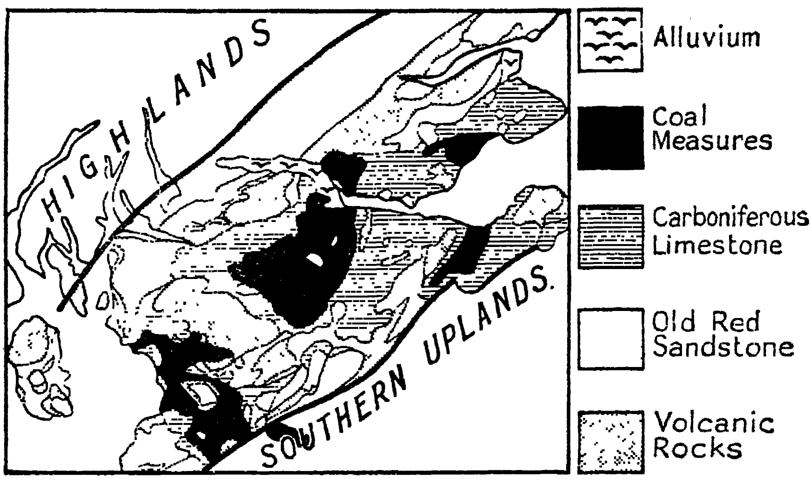


FIG. 23.—The geology of the Midland Valley.

Note the separation of the Ayrshire and Central coal basins by the Cunningham axis of uplift (N.W.—S.E.) and the separation of the Central and Midlothian by the Pentland axis (S.W.—N.E.).

(4) **The Lake District or Cumbria.**—The folding of the mountains which now make up the Lake District probably commenced even as early as Ordovician times, but the main earth movements responsible for the formation of the group were, like those of the Southern Uplands and of the Highlands, the great

Caledonian movements. Consequently the geological structures in the main part of the Lake District have a trend from south-west to north-east and there is no doubt that originally the Isle of Man and the Lake District were joined and formed a single great chain of mountains. But the mountains suffered great denudation, and at a later stage the waters of the Carboniferous sea washed round them and may even have submerged the whole, so that Carboniferous Limestone was deposited on the flanks of the old central core. At a later stage—probably during the Alpine earth movements—

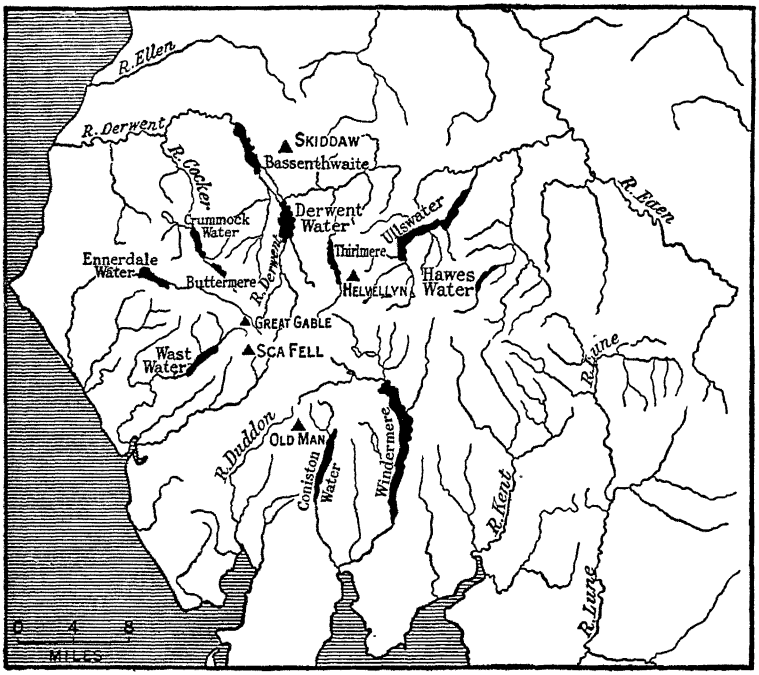


Fig. 24.—The radial drainage of the Lake District.

a local uplift occurred in the heart of the Lake District. The uplift may have been due to a great mass of molten material in the lower layers of the earth's crust attempting, without success, to force its way to the earth's surface. Whatever its cause, the uplift has undoubtedly resulted in the two great characteristic features of the area of the present day. These two features are the occurrence of the main mass of ancient rocks in the heart of the area, surrounded by younger rocks which in general dip away from the centre core. In the second place the uplift seems to have been responsible for the initiation of one of the most remarkable examples of radial drainage which is known. The well-known lakes of the Lake

District radiate like the spokes of a wheel from a central hub, and it is because this uplift took place at a comparatively late stage that the forces of denudation are still active. Thus the Lake District has some of the finest rock scenery and, despite their relatively low altitude, rugged mountains in the British Isles. Geographically there is a remarkable contrast between the area of ancient rocks in the heart of the Lake District and the surrounding ring of younger strata. Only on the south-east do the Shap Fells connect the Lake District proper with the hill masses of the Pennines.

(5) **Wales or the Welsh massif.**—For the purposes of a general account the whole of the Welsh massif may be considered together. For this purpose the massif may be described as embracing all the hill masses which lie to the west of the English Midlands, excluding only the southern part of the county of Glamorgan, which actually ought to be considered as part of the English plain or scarplands. The eastern margins of the area so defined can be quite clearly traced from any physical map. In the north the Welsh hills abut quite abruptly on the Cheshire and north Shropshire plain; along the margin lies the North Wales Coalfield. The hills of central and southern Shropshire belong structurally to the Welsh massif, and from central Shropshire southwards to the mouth of the Severn the eastern limit is defined by the line of hills running southwards from the Wrekin in Shropshire to the Abberley Hills and the Malvern Hills. The oldest part of the Welsh massif is in the north-west, where the ancient crystalline rocks of the isle of Anglesey underwent folding in Pre-Cambrian times. The folding was continued during the Caledonian earth movements and post-Carboniferous foldings followed along the same lines, so that one finds narrow bands of Carboniferous Limestone pinched in amongst the ancient rocks. The whole of Anglesey, as the result of later denudation, has been worn down to a low plateau, almost to a sea-level plain, and its complicated geological history is scarcely suggested by the somewhat uninteresting topography of the island. The mainland of north Wales is still, on the other hand, a land of rugged mountains. On the whole the grain of the country is from south-west to north-east, indicating that the mountains owe their origin in the main to the Caledonian earth movements. The rocks involved in the folding are, for the most part, Cambrian, Ordovician and Silurian, but the mountains owe their rugged character of to-day to the large masses of contemporaneous lava which were extruded as well as to other igneous masses which were intruded into the rocks before and during the folding. The igneous rocks have proved themselves more resistant to weathering, and most of the higher points, such for example as Snowdon and Cader Idris, mark the outcrop of one or more masses of igneous rock. As

one passes from north into central Wales, the igneous masses become less numerous, and this is one reason for the less rugged topography of central Wales. The age of the folding of the rocks, too, becomes successively younger as one goes towards the south. Whilst north and central Wales, which at that time were probably continuous with south-eastern Ireland, formed the land mass which we have already called St. George's Land in Carboniferous times, south Wales was occupied first by the Carboniferous Limestone sea, then by the fringing swampy lands on which grew the Coal Measure forests. Coal Measures were laid down over a huge area in South Wales, and at the end of the Carboniferous period were folded by the Carbo-Permian or Armorican earth movements. These earth movements resulted there in folds with an east-west trend, thus causing the great coal basin of the South Wales Coalfield. It would seem that the Armorican earth movements were unable to fold the already highly complicated and hardened masses of North Wales, and that the earth-building waves broke against this resistant mass both along its southern and eastern sides. Thus there are east-west folds in the south, but north-south folds in the east. Some of the latter are remarkably sharp, and one forms that curious line of hills, the Malvern Hills. The Malvern Hills folds are typical of the group with a north-south trend which is sometimes referred to as the Malvernian group. Where the north-south and east-west folds cross, small nodes and basins were formed of which the Forest of Dean coalfield is an excellent example.[1]

It will be seen that a triangular space remains between the east-west Carboniferous folds of South Wales, the north-south Malvernian folds of the eastern margin, and the south-west to north-east Caledonian folds of central Wales. This triangular space is occupied mainly by rocks of Old Red Sandstone age. Where the rocks consist mainly of hard red sandstones and conglomerates, they give rise to high moorland country such as that of the Brecon Beacons, including indeed some of the wildest moorland country in the whole of the British Isles. Where the Old Red Sandstone consists, on the other hand, of comparatively soft red marls low-lying ground has resulted, in particular the famous fertile plain of central Hereford which is thus a basin-shaped plain lying within the bounds of the Welsh massif. An attempt has been made in Fig. 26 to divide the Welsh massif into its smaller constituent regions.

(6) **The Peninsula of Devon and Cornwall.**—The south-western peninsula is the third of the masses of ancient rocks which occur on the western side of England and Wales. It is very different in character from the Lake District massif, and also from the Welsh massif. The folding of the rocks is very complicated and took place, for the most part, during the Carbo-Permian or Armorican

[1] Still better shown in the complicated Bristol district, and the Mendips.

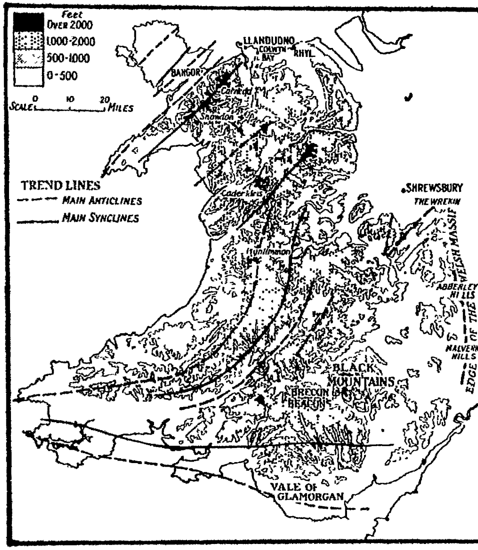


FIG. 25.—Physical map of Wales showing trend-lines.

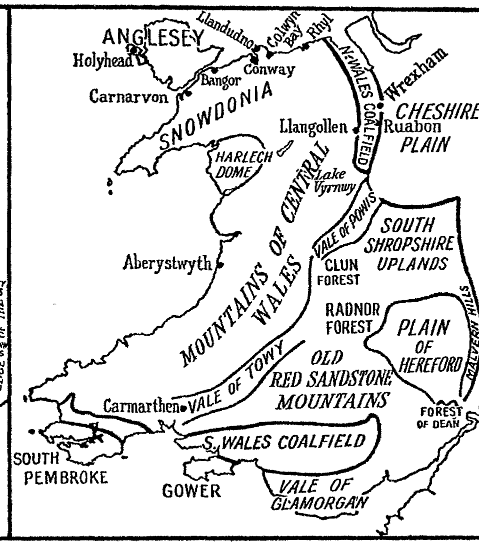


FIG. 26.—Wales, showing a division into physiographic regions.

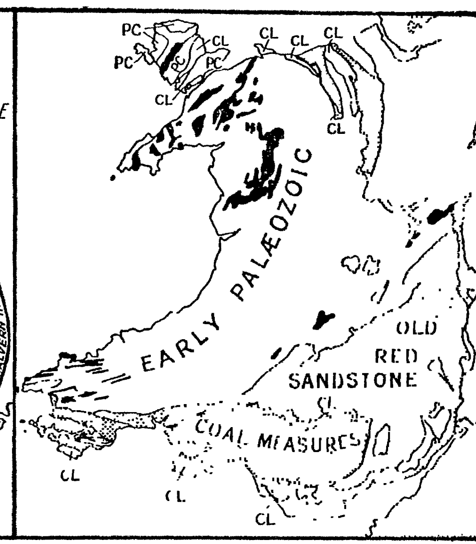


FIG. 27.—Geological map of Wales.

Black = igneous rocks; PC = Pre-Cambrian; CL = Carboniferous Limestone.

Stipples have been omitted in error from the Old Red Sandstone of Clun Forest and from the Coal Measures of the Forest of Dean.

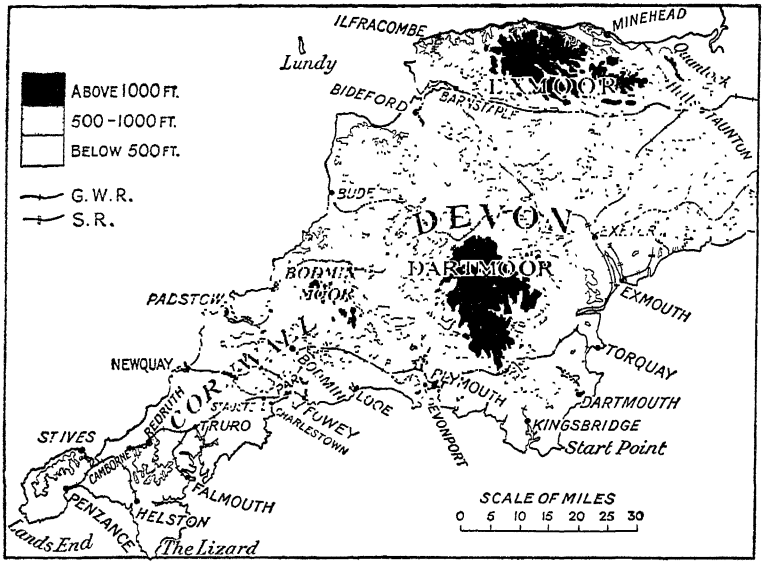


FIG. 28.—Physical and general map of the South-Western Peninsula.

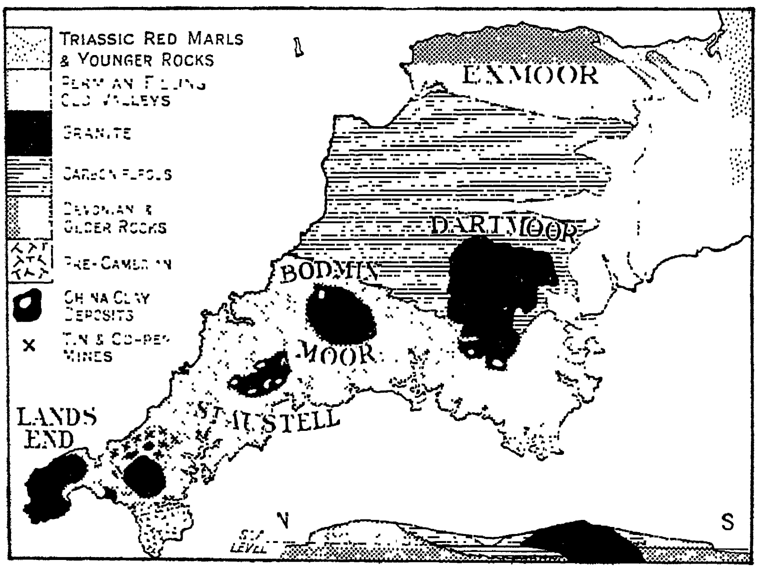


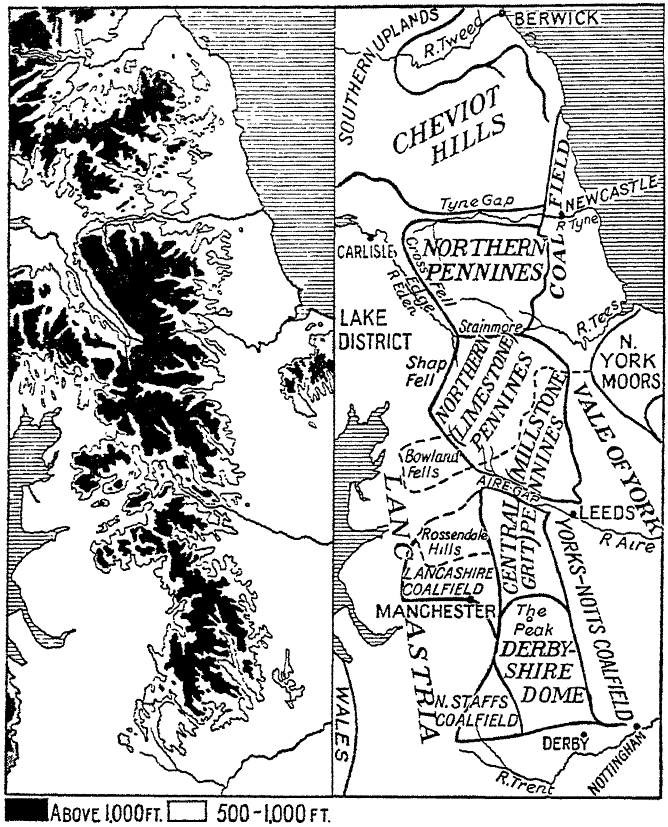
FIG. 29.—Geological sketch map of the South-Western Peninsula.

A comparison with Fig. 28 will suggest the correlation between the granite masses and higher areas of the plateau surface—with Exmoor as an exception. The section is from Exmoor through the Dartmoor granite.

earth movements, and the strike of the folds is east to west. During the folding there was an intrusion of large granite masses. Thus from early Permian times onwards, as already pointed out, there must have been great east and west mountain chains separated by deep rock-girt basins in which the Permian and Triassic rocks were laid down. But through the long ages since, denudation has been active, and the ancient mountain chains have been worn down until now there are certainly no rugged mountains in Devon or Cornwall. Instead there is an elevated plateau rising to its greatest heights either where the old rocks are very hard or tough, as in Exmoor, or where the granite masses have offered a greater resistance to denudation than the surrounding sediments, as they have in Dartmoor and Bodmin Moor and other areas. The south-western peninsula also seems to have undergone a comparatively recent general uplift, so that at the present day we may best describe the area as a plateau with an undulating surface—a plateau which meets the present ocean in the long succession of rugged cliffs, so characteristic of the coasts of Devon and Cornwall. It should be mentioned that a part of western Somerset (the Quantocks) is also included within this region. The higher levels of the plateau are occupied by moorlands, but much of the remainder is cultivated, since the Devonian and Carboniferous rocks break down into a moderately rich soil. The comparatively mild climate, specially of the more sheltered valleys, is responsible for the special vegetation and utilisation features of these valleys both in Devon and Cornwall.

(7) **The Pennines.**—The Pennines, or the "Backbone" of England, are sometimes wrongly referred to as a chain of mountains. This term is entirely incorrect, and it is not wise to apply even the term "range" to them. It is much more suitable that they should be referred to as the Pennine Upland. It is probable that Coal Measures were deposited, as we have already seen, right across the north of England, and that the Pennine Uplift dates from post-Carboniferous times, that is from the Carbo-Permian earth movements. The Pennines are often represented in diagrammatic sections as if they were a simple anticline. Broadly speaking, however, the fold, if such it may be called, is defined by a series of great faults on the west, and consequently the highest portion of the Pennines is usually the western margin overlooking the lowlands to the other side of the boundary faults. The Carboniferous Limestone and Millstone Grit rocks which make up the bulk of the moor-covered Pennine Uplands are themselves but slightly folded, often almost horizontal, but towards the east they take on a general dip towards the North Sea, so that on the eastern side the Pennines fade gradually into the lower ground bordering the North Sea itself. Important transverse valleys divide the Pennines into four blocks:

these are shown on Fig. 30 in relationship with the main outcrops of Carboniferous Limestone and the Millstone Grit. In the north the Cheviot Hills, largely built up of volcanic material, form a connecting link between the Pennines and the Southern Uplands of Scotland.



FIGS. 30–31.—The Pennines.

The remainder of England is occupied for the most part by lowlands, and is built up mainly of rocks younger than those which form the Highland Zone. For purposes of description, the following broad regions may be distinguished.

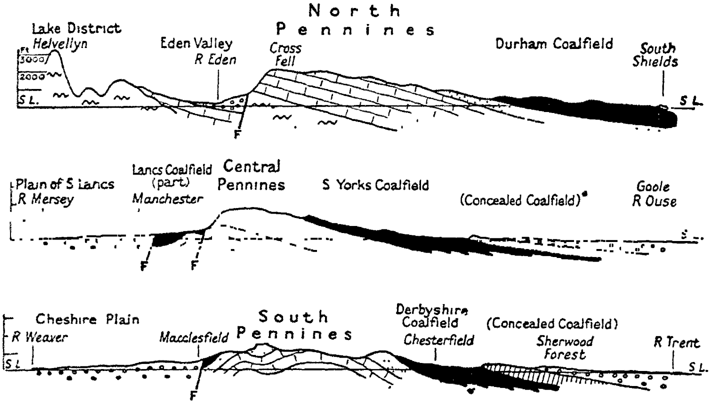


FIG. 32.—Sections across the Pennines.

The geological formations shown are: Lower Palæozoic Slates (wavy lines), Carboniferous Limestone (brickwork), Millstone Grit (dots), Coal Measures (black), Magnesian Limestone (vertical lines), Trias (circles). Note the asymmetrical character of the uplift and the variation in structure from north to south.

B. THE LOWLAND ZONE

The Triassic Plain of the Midlands.—The Midlands of England, in a somewhat restricted sense, consist for the most part of lowland, and occupy a V-shaped area. The southern end of the Pennines fits into the centre of the " V," the left arm of which joins the lowlands of Cheshire and Lancashire, through the Midland Gap, while the right arm joins the lowlands of the Vale of York by way of the broad lower Trent Valley. Geographically the Midlands so defined may be regarded as bounded on the south-east by the first of the " scarps " which make up the scarplands of south-eastern England. On the west the Midlands stretch as far as the edge of the Welsh massif, which has already been described. The point of the " V " stretches to the Severn estuary and extends through the interesting, if complex, Bristol-Mendip region into the Plain of Somerset. The most important of the geological formations in the Midlands is the Upper Trias or Keuper Marls, which weather to a rich red soil excellent for cattle pastures and for cultivation. The Triassic Marls are very similar to the Old Red Marls of Herefordshire. Both give rise to lowlands. The Lower Trias or Bunter is a formation of sandstones which results in rather higher and less fertile country, such as the Cannock Chase plateau. The whole of the Trias, as already explained in Chapter II, was originally laid down in a shallow inland basin under almost desert conditions (compare

the Great Salt Lake of Utah at the present day), and the Triassic deposits are found wrapping round masses of older rock which formed islands in the old lake basin. The "islands" include the small coalfields of the Midlands, and since they give rise to industrial areas in the midst of country otherwise agricultural they should be considered separately, together with the "islands" of still older rocks.

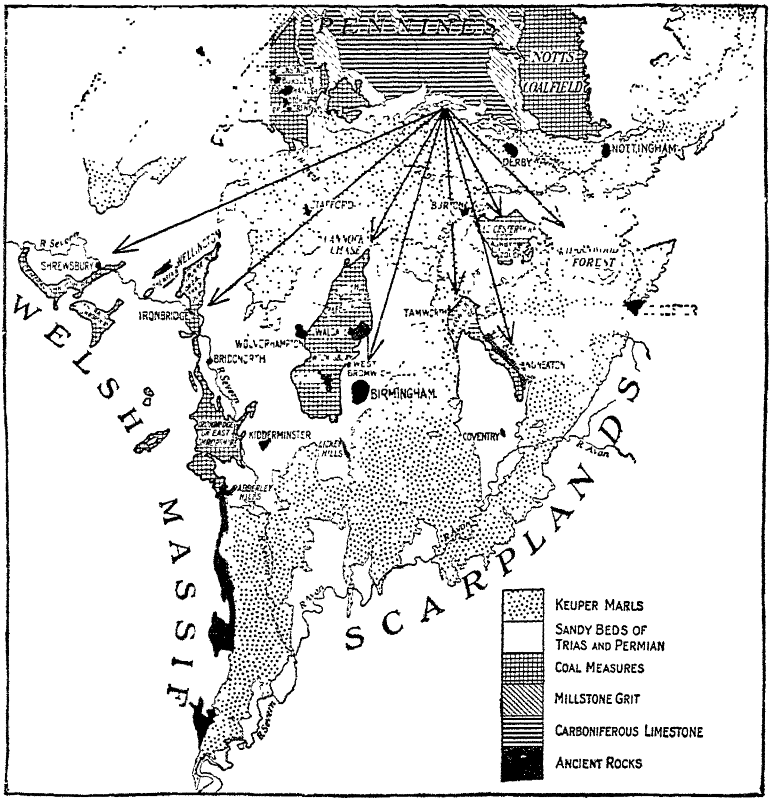


FIG. 33.—The ancient islands of the Midlands.

The "Islands" of Old Rocks in the Midlands.—These islands of old rock are best considered in relation to the southern end of the Pennines. Taking a point at the southern end of the central limestone core of the Pennines, just west of Derby, it is possible to draw radiating lines each passing through one of the old islands. This has been done in Fig. 33.

(*a*) *Charnwood Forest* lies to the south-east of the Southern Pennines. It consists of very ancient (Pre-Cambrian) rocks, though all but the highest hills of the ancient island have been covered with Triassic deposits. But the geology makes Charnwood

Forest quite different from the surrounding country. There are pretty wooded hills and winding leafy lanes, and the whole area is one of the playgrounds of the Midlands. Some of the old rocks are quarried for road metal, which is used all over southern England.

(b) *The Leicestershire Coalfield* lies next to Charnwood Forest on the west. It is one of the few coalfields of England which has

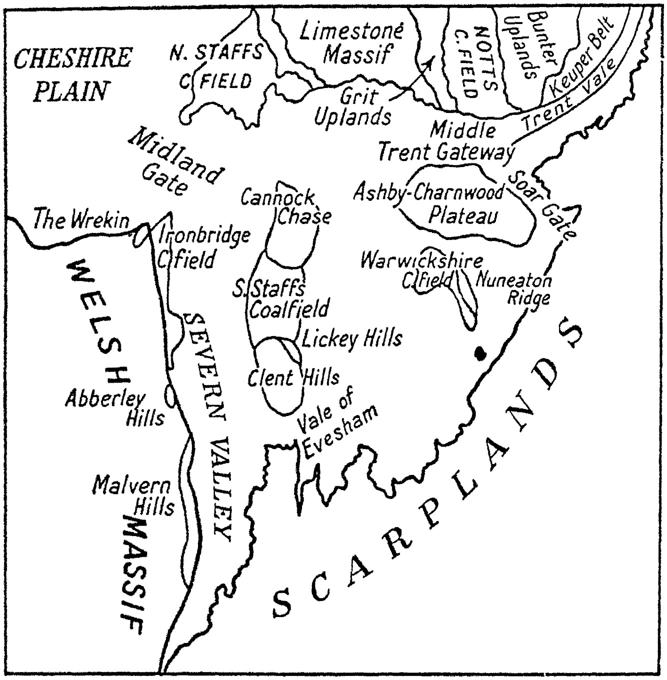


FIG. 34.—Sketch map showing physiographic subdivisions of the Midlands. The north-eastern part is after Professor H. H. Swinnerton.

not given rise to an extensive industrial area. The coalfield and Charnwood Forest form an upland area which has been called (as on Fig. 34) the Ashby-Charnwood Plateau.

(c) *The Nuneaton Ridge*, a narrow ridge of ancient rocks similar to those of Charnwood Forest, lies almost due south of Derby.

(d) *The Warwickshire Coalfield*, sometimes called the Nuneaton Coalfield, lies to the west of the Nuneaton Ridge, just as the Leicestershire field lies to the west of Charnwood Forest.

(e) *The Lickey Hills*.—Due south from the centre of the Pennines the line passes nearly through Birmingham and then through a very small island of ancient rocks like those of the Nuneaton Ridge—these are the Lickey Hills.

(*f*) *South Staffordshire Coalfield.*—This large and important coalfield lies immediately to the north-west. The northern part is a broad plateau, continued northwards by Bunter Sandstones and known as "Cannock Chase," whilst a continuation southwards of the Bunter Sandstone gives rise to the Clent Hills. Associated with this coalfield is the famous "Black Country."

(*g*) *The Ironbridge and Forest of Wyre Coalfield* (East Shropshire Coalfield) is a long, narrow coalfield stretching southwards from Wellington and lying along the edge of the Welsh massif. It is cut through by the gorge of the Severn.

(*h*) *The Wrekin*, a hill of ancient rocks near Wellington, has already been mentioned as part of the outer rampart of the Welsh massif. It is part of the area of old rocks which occupies central Shropshire.

Having now dealt with the islands of old rocks which give rise to most of the industrial areas of the Midlands, it remains to note a few points about the surrounding regions of Triassic rocks.

The Bunter Sandstones, as already noted, coincide with low uplands, the Keuper Marls with low ground, gently undulating but otherwise rather featureless.

To the south-east the Keuper Marls are succeeded by the Rhætic and Liassic rocks. Unless these contain hard or resistant beds sufficiently important to give rise to a scarp there is little to mark the junction. Thus the Vale of Evesham is partly on Keuper, partly on Lias; so also is the Vale of Berkeley.

The Plain of Lancastria.—The plain of Lancastria forms a continuation of the Midland Plain through the Midland Gap or Midland Gate. It occupies the northern half of Shropshire, nearly the whole of Cheshire and that part of Lancashire which lies between the Pennines and the Irish Sea. There are two broad tongues of moorland, called respectively Bowland "Forest" and Rossendale "Forest," which extend westwards from the Pennines into Lancashire and which coincide with anticlines of Carboniferous Rocks (Millstone Grit and Lower Coal Measures). Elsewhere Lancashire is an undulating lowland: again, where Bunter Sandstones outcrop there may be low hills, where the Keuper Marls are at the surface true lowland prevails. The actual character of the surface, however, depends largely on the thickness and type of the mantle of glacial deposits. Physically the plain of Lancastria lies between the Welsh massif and the Pennines: on the west the undulating country of the North Wales Coalfield forms a transitional belt; in the east the rather infertile sandy country of the North Staffordshire Coalfield forms a similar transitional belt.

The North-Eastern Lowlands of Nottinghamshire, Yorkshire, Durham, and Northumberland. On the eastern side of the Pennines, and thus corresponding to the Plain of Lancastria on the west, is

a broad belt, mainly of lowland. The Carboniferous Limestone and Millstone Grit formations which make up the bulk of the Pennines dip eastwards, and are succeeded in turn by the Lower Coal Measures, the Middle and Upper Coal Measures, the Magnesian Limestone and higher Permian beds, the Bunter Sandstone and the Keuper Marls. In general terms each succeeding formation gives rise to its own characteristic type of country. Thus there is a succession of physiographic zones roughly parallel to the Pennines. The Lower Coal Measures give rise to rather barren land with patches of moorland separated from one another by river valleys. The more fertile country of the Middle and Upper Coal Measures has a gentler relief, but resistant beds may form westward facing scarps (see Fig. 211). Tongues of lowland extend into the heart of the Pennines along the famous "Yorkshire Dales"—particularly those formed, from north to south, by the Swale, Ure, Nidd, Wharfe, Aire, Calder, and Don. The Magnesian Limestone usually forms a distinct westward facing scarp, often with attractive cliff scenery, especially at those parts where the scarp is cut through by rivers. The Bunter Sandstone, as in the Midlands, coincides with sandy, rather elevated tracts, infertile and hence often well wooded as in the well-known Sherwood Forest. Occasionally marked bluffs are found, such as that on which Nottingham Castle is situated. The final belt is that of the Keuper Marls and is the lowland belt which stretches from the mouth of the Tees to the Trent Vale of Nottinghamshire, but the Keuper Marls are masked by superficial deposits over large areas, particularly over that huge tract known as the Vale of York, and the interesting area of the Isle of Axholme.

The Bristol-Mendip Region.—To the south-west the Midland Plain narrows and passes first into the Vale of Gloucester and then into the Vale of Berkeley between the Forest of Dean or the Severn on the west, and the fine scarp of the Cotswolds on the east. But further southwards, in what may be called the Bristol-Mendip Region, the plain disappears. Its place is taken by country of varied topography lying between the Severn and the westernmost of the Jurassic scarps. This region repeats, on a smaller scale, the features of parts of the Midlands. It really consists of "islands" of old rocks wrapped round by the softer Triassic and Liassic deposits. But there are several points of difference: the islands are relatively larger and more numerous, the amount of low ground correspondingly small. The islands, too, are of rocks of varied age; there are the large Carboniferous Limestone masses of the Mendip Hills, and the important coal basins, as well as quite tiny patches of Silurian, Old Red Sandstone and Carboniferous Limestone. The "islands" are remnants of Armorican folds, and it is in this region that the north-south Malvernian folds cross the more normal east-west folds which have, however, in the Mendip Hills assumed

a direction rather west-north-west to east-south-east. Thus some of the old blocks are elongated in a north-south direction (*e.g.* the Tortworth Ridge north of Bristol and the Carboniferous Limestone edges of the Kingswood coal basin), others in the direction exemplified by the Mendip Hills.

The Plain of Somerset.—In some ways this plain resembles that of the Midlands from which it is separated by the Bristol-Mendip region. The Vale of Taunton Deane is thus a Keuper Marl

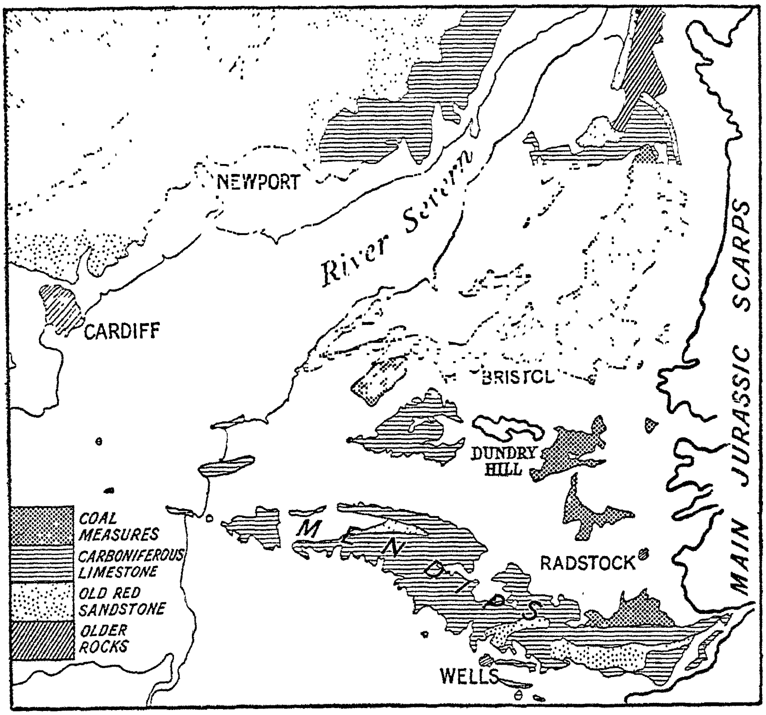


FIG. 35.—The Bristol-Mendip Region, showing the islands of old rocks. The unstippled land areas are Triassic and lower Jurassic rocks and recent deposits.

lowland, but the great feature of Somerset is the very extensive plain, almost at sea-level and liable to extensive floods, which lies between the Quantock Hills and the Mendip Hills, and which is interrupted only by the narrow Liassic ridge of the Polden Hills.

The Jurassic Scarplands.—The Jurassic rocks of Britain crop out over a belt of varying width extending from the Dorset coast to the north Yorkshire coast. Over large areas the beds dip to the south-east or east, and so give rise to a succession of hills or ridges where the harder or more resistant beds crop out, and valleys or negative relief where the softer or more easily eroded rocks occur.

The hills usually have a steep scarp slope on the one side, generally to the north-west, and a long gentle dip slope on the other. Whilst the general arrangement is that suggested in Fig. 36, it is a mistake to imagine a continuous Jurassic limestone scarp running right across the country. The hill-belts and scarps are not formed by a single rock formation, but by different rock groups in different areas. The scarps swing about in different directions, die away, and start again. In some parts of the Midlands, the dip slope of the resistant beds is so slight that the structure of the country becomes that of a dissected plateau. Thus the Jurassic scarps are not nearly as constant as that of the Chalk.

In the first place the Jurassic rocks were laid down in shallow water, and consist of a varied series of clays, fine and coarse sands, sandstones and limestones. Some of the latter are oolitic, but the importance of the oolitic limestones has been over-emphasised as a result of their economic value as building stones or for lime. The

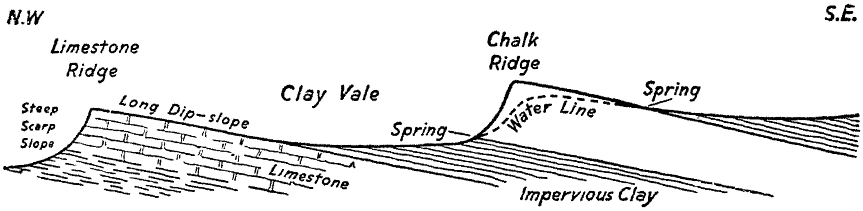


FIG. 36.—Diagrammatic section illustrating the succession of clay vales and limestone or sandstone ridges found in the south-east of England.

variability of the Jurassic succession was enhanced by the presence within the sea of three axes of uplift which, by separating the sea into four different basins, allowed a different succession of clays, sands, and limestones to accumulate in each basin. Along the axes, which lay respectively east-west across South Yorkshire, north-west to south-east across Oxfordshire and west-north-west to east-south-east along the line of the Mendip Hills in Somerset, the whole Jurassic sequence is naturally thin.

An attempt has been made in Fig. 37 to show the actual position of the true scarps.[1] Those shown have a minimum slope of 1 in 10. The scarplands may be divided as follows :

(1) *The Northern Basin of Deposition.*—The Cleveland and Hambleton Hills of North Yorkshire. Here the wavy dissected scarp, 600 feet high, with its deep valleys and its plateau-like surface, is formed by thick sandstones of Inferior and Great Oolite Age, accentuated by the resistant nature of the underlying Upper and Middle Lias beds which form the lower portion of the cliff.

(2) *The Market Weighton Uplift* of South Yorkshire. The thin Jurassic rocks are overlapped by the Chalk and there is no Jurassic scarp.

[1] For full details, see S. H. Beaver, "The Jurassic Scarplands," *Geography,* XVI, 1931, 298–307.

(3) *The Central Basin of Deposition*—in Lincolnshire and Northamptonshire.

(*a*) In Lincolnshire the remarkable Lincoln Cliff, from 100 to 200 feet high, runs north and south in an almost straight line, broken only by the Witham Gap on which Lincoln is situated. It is formed by the Lincolnshire Limestone (Inferior Oolite); to the west is the low ground on soft Liassic Clays; to the east low ground again.

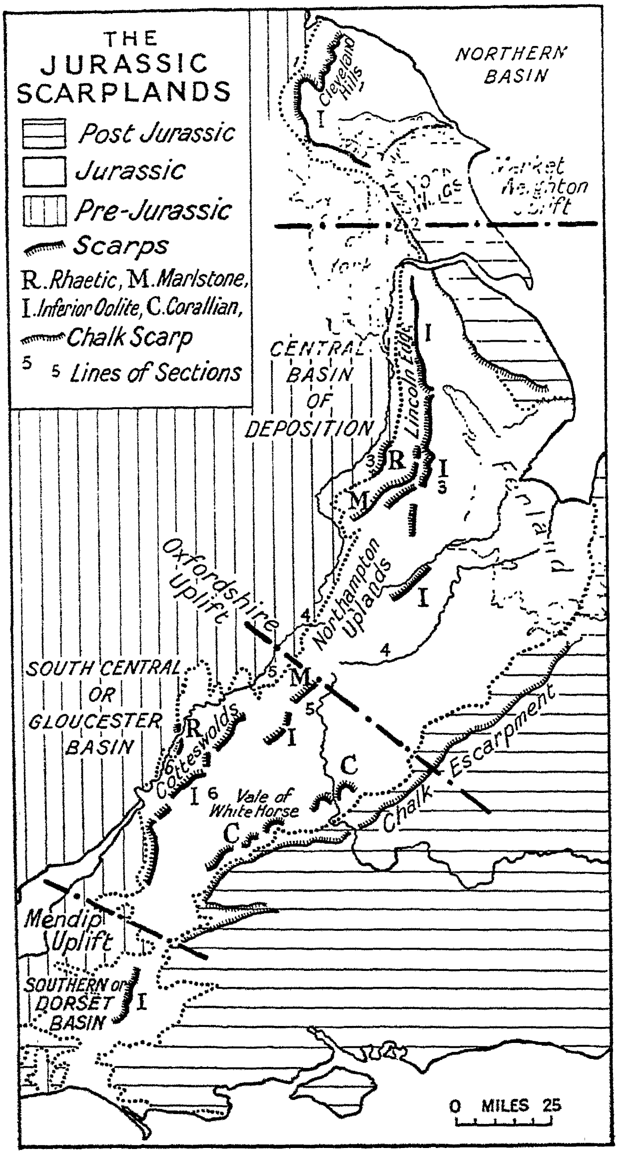


FIG. 37.—The Scarplands of the south-east of England.

(*b*) In south Lincolnshire and Leicestershire there are three distinct scarps. The Rhætic limestone forms a small ridge, of no great extent, some 10 miles west of Grantham. Eastwards are wide lowlands on Lower Lias Clays; then, beginning near Caythorpe, and increasing in height as it swings south-westwards to form the Melton Mowbray ironstone ridge, is the scarp, about 150 feet high, formed by the Middle Lias marlstone. Further east is the Upper Lias clay vale, then a scarp 200 feet high which marks the edge of a Lincolnshire limestone plateau. The last scarp continues, rather more broken, south of Grantham and overlooks the Vale of Catmoss in Rutland and the Welland Valley in Northamptonshire.

(*c*) In eastern Warwickshire and Northamptonshire there are really no scarps, but instead an area of undulating topography and a watershed where a number of important streams rise. Many of the rocks present are resistant, so the area is in the main an upland.

(4) *The Oxfordshire Uplift* in south-eastern Warwickshire and north Oxfordshire. Here the Lower Lias limestones continue to form an upland

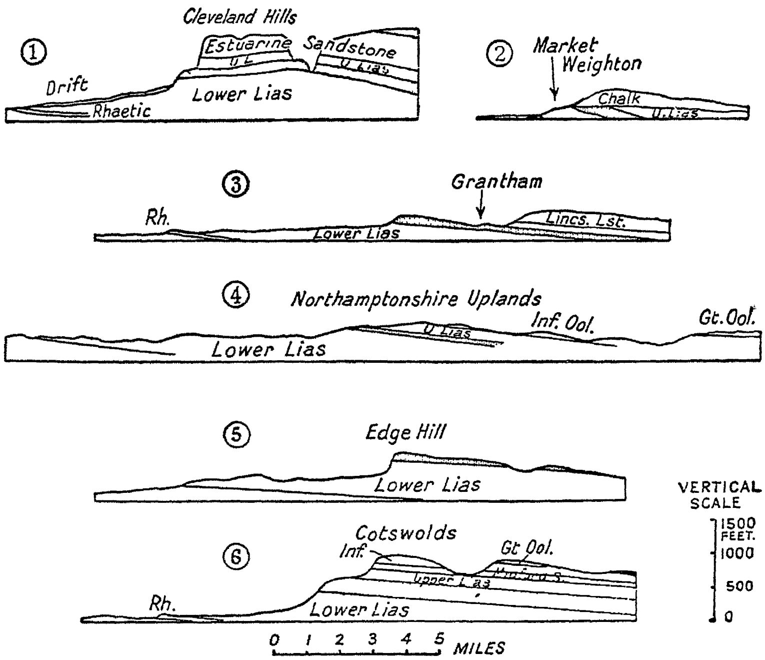


FIG. 38.—Some typical sections across the scarplands.

The numbers refer to the lines of section shown on Fig. 37. Stippled band = Middle Lias (mainly sandstone and marlstone).

and the Marlstone makes the marked feature of Edge Hill, but the Inferior and Great Oolites are poorly developed and give rise to undulating ground.

(5) *The South-Central or Gloucestershire Basin of Deposition.*—Here the great scarp of the Cotswolds, 600 feet high, dominates the whole country. The scarp is formed in the main by the Midford Sands and the limestones and grits of the Inferior Oolite, but the extensive dip slope is usually capped by the Great Oolite limestone and Forest Marble. Frequently the main scarp is "stepped," a lower step or shelf being formed by the

Middle Lias Marlstone. To the west there is locally a small Rhætic scarp; to the east the Cotswolds slope gradually towards the great Clay Vale (including the Vale of the White Horse) and only in some places is the eastern side of the Vale interrupted by a small scarp formed by the Corallian.

(6) *The Mendip Uplift.*—The Oolitic escarpment ceases to be clearly recognizable south of Bath. All the Jurassic divisions tend to become thin and to lose their normal lithological character towards the Mendips where there was an axis of uplift during the time of their deposition.

(7) *The Southern or Dorset Basin of Deposition.*—Southwards from the Mendips the Jurassic succession resumes again its normal features (in the Dorset basin of deposition), and the Oolites, together with the Upper Lias, form a prominent escarpment of Cotswold type separating the Vale of Blackmore on the south from the Somerset lowlands on the north. Further south the area is dominated by the Upper Greensand scarp of the Blackdown Hills and the Chalk Heights of Dorset.

It will be clear that the great Clay Vale is formed in the main by the clays of the Upper Jurassic. In Yorkshire it is represented by the old glacial lake basin of the Vale of Pickering (on Kimmeridge Clay). The Lincoln Vale is on the Oxford and Kimmeridge clays, and broadens out southwards to the great flat of the Fens where the solid geology is completely masked. Beyond this is the clay vale drained by the middle portion of the Ouse, on which stands Bedford. A low divide separates this area from the wide clay Vale of Aylesbury in the drainage basin of the Upper Thames. This Vale owes its existence to the thick and almost continuous succession of Upper Jurassic and Lower Cretaceous Clays. It is continued westwards in the Vale of Oxford, and the Vale of White Horse, but here the clay vale becomes interrupted by the Corallian scarp, and there are local features, such as Shotover Hill, formed by Portlandian rocks.

The accompanying sections illustrate not only the scarp-forming formations, but also the general Jurassic sequence.

The Chalklands.—That pure white limestone known as chalk, although soft, is more resistant to weathering than the clays or sands which underlie it and the more recent sediments by which it is sometimes succeeded. As a formation it is thick—600 to 1,000 feet generally—and varies but little from Yorkshire to the Isle of Wight. Consequently it gives rise to a scarp, in general westward facing, which is both more conspicuous and more continuous than the scarps formed by the Jurassic rocks. Only rarely—as in the East Anglian Heights—is this feature inconspicuous, even more rarely is it absent. The dip slope of the chalk is characteristically "rolling" country and innumerable dry valleys are a constant feature. Where the chalk is almost horizontal large stretches of rolling downland (typified by Salisbury Plain) result; where the dip of the beds is steep there is little difference between the dip slope and the scarp slope and "hog's back" lines of hills result, like the Hog's Back between Guildford and Farnham. The belt of chalklands commences in the north in Yorkshire (where it forms the Yorkshire Wolds). It is interrupted by the Humber and forms

the ridge through which that river passes just before reaching Hull. Southwards are the Lincolnshire Wolds, as far as the second interruption caused by the Wash. In both the Yorkshire and Lincolnshire Wolds the character of the chalklands is modified by a thick mantle of glacial deposits. From the chalk cliffs of Hunstanton in Norfolk, the scarp is represented merely by low hills overlooking the Fens. In the neighbourhood of Newmarket, the chalk hills become more distinct (East Anglian Heights) and gradually the great stepped scarp of the Chiltern Hills becomes increasingly marked. The River Thames cuts through the chalk ridge by the Goring Gap. In Berkshire and northern Wiltshire the chalk outcrop broadens to form the Lambourn and Marlborough Downs. In this part of England certain beds below the chalk, especially the Upper Greensand (here a close-grained loamy clay), assume a special significance. The important Vale of Pewsey is floored by the Upper Greensand and the morphological features of this Vale are particularly interesting. To the south is the great stretch of Salisbury Plain. The chalk downs extend into Dorset. From here westwards an important feature is formed by the Greensand deposits—here with more resistant beds—which give rise to the Blackdown Hills.

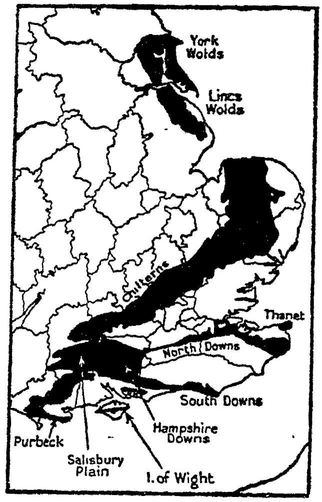


FIG. 39.—The Chalklands of England.

Along the south coast tracts, Britain was considerably affected by the Alpine earth movements, and the highly folded chalk—almost vertical in places—gives rise to a ridge through the Isle of Purbeck and then the Isle of Wight.

To the north and south of the Weald are the North Downs and South Downs respectively (see below, p. 50).

The Weald.—Originally the whole of south-eastern England was covered with a thick mantle of chalk, and the uplift of the Wealden dome took place during the Alpine earth movements. The crest of the dome, which is elongated from east to west, trends on the whole in that same direction, but the axis curves towards the south-east when followed over the Straits of Dover into the northern part of France. The Weald of Kent, Surrey, and Sussex forms classic ground in many respects, for it was here that W. M. Davis [1] studied the evolution of the river system and introduced those

[1] "The Development of certain English Rivers," *Geog. Jour.*, V, 1895, 127.

terms which have now become universal. From the central ridge of the upfold, the rivers drain off to north and to south. Their direction was a consequence of the structure of the ground, and hence such streams are called "consequent." As the rivers and other agents of denudation continued their work so the chalk was entirely removed over the central area and the underlying rocks were exposed. The softer beds, such as the clays, were worn away by streams running into the consequent rivers at right angles. These streams developed subsequently to the earlier ones and so are called "subsequent." Still smaller streams, which joined these at right angles in such a way that their direction of flow was often opposite to that of the consequent streams, are known as "obsequent." The rocks underlying the chalk in the Weald belong to the Lower Cretaceous Series, and there are alternating soft, or easily eroded, beds, mainly clays, and harder, or more resistant beds, mainly sands and sandstones. One thus has a repetition in miniature in the Weald of the features of the scarplands of England, with each successive ridge showing a scarp facing towards the

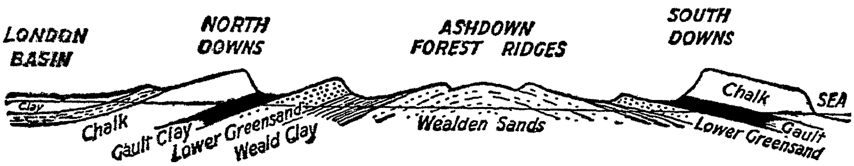


FIG. 40.—Diagrammatic section across the Weald from north to south.

centre, as suggested in Fig. 40. At a late stage in the history of the area, the Straits of Dover were cut and occupied by the sea across the eastern end, so that the extreme east of the Weald is actually in France. In the heart of the Weald as it is to-day is a group of sandy beds forming hills once covered with thick forest, and so often known as the Forest Ridges. Surrounding these hilly central tracts is a belt of lowland where the Weald Clay and certain other clayey beds are found, then a belt of hills formed by the harder beds of the Lower Greensand, then again a valley, called in the north the Vale of Holmesdale, which marks in the main the position of the soft Gault clay. Then comes the main ridge of all, formed by the chalk, well known as the North Downs in the north and the South Downs in the south. The Downs present a steep scarp slope inwards towards the heart of the Weald, and then a long gentle dip slope in the reverse direction. Sometimes the dip of the chalk is steep, as in the famous Hog's Back west of Guildford, and the apparently simple structure shown in the diagram may be complicated locally, especially where the escarpments are "stepped" and certain horizons, *e.g.* the Lower Chalk, give rise to platforms. Although the Weald is thus a well-marked region, it will be seen

that it comprises a number of different parts, which may now be separately considered.

(*a*) *The Forest Ridges or the High Weald,* usually built up of various groups of sand, particularly the Ashdown Sands, the Tunbridge Wells Sands, and the Hastings Sands, once densely forested and important for the supply of timber for charcoal for the now defunct iron industry.

(*b*) *The Weald Clay Vale,* a region of negative relief, still very wet, mainly occupied by pasture lands with scattered remnants of the once continuous cover of damp oak woodland. It is a tract in which older settlements and villages are relatively few.

(*c*) *The Greensand Ridge* or the tract of well-drained land with numerous springs on the flanks. Sometimes the land is highly cultivated, but where the sand is coarse the soil may be poor and there are wide stretches of heathland. The Greensand ridge passes towards the western edge of the Weald into a broad tract of undulating, dry, heathy country which has

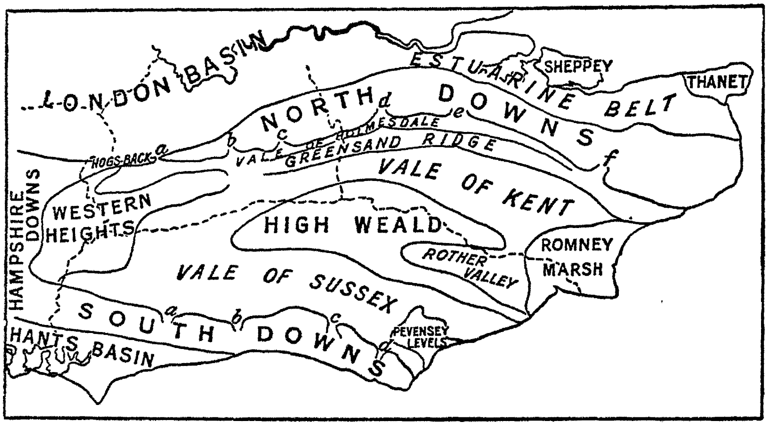


FIG. 41.—The minor regions of the Weald.

been called the Western Heights. It should be noted that the Lower Greensand does not give rise to a distinctive region on the southern side of the Weald.

(*d*) *The Vale of Holmesdale* is another tract of damp clay lands, but at the foot of the downs there is usually a strip where the Upper Greensand and Lower Chalk outcrop and where there are good, rich mixed soils, largely cultivated.

(*e*) *Romney Marsh* is a separate area within the Weald, now drained and occupied by pastures, whilst *Pevensey Marsh* is a similar area though its utilisation is different (see p. 191).

Strictly speaking the Weald may be regarded as limited by the main crest of the chalk scarp, but it is often convenient to consider as belonging to it the chalk downs as well. When one remembers that the chalk ridge maintains an average elevation of 500 to 700 feet, and that there is a drop of 400 feet or more to the Gault Clay Vale, the importance of the gaps through the ridge is at once

apparent. Along the North Downs the chief gaps and gap towns from west to east are (the letters refer to Fig. 41):

(*a*) The Wey Gap—Guildford.
(*b*) The Mole Gap—Leatherhead and Dorking.
(*c*) The Merstham Dry Gap—Redhill and Reigate.
(*d*) The Darent Gap—Otford and Farningham.
(*e*) The Medway Gap—Rochester.
(*f*) The Stour Gap—Canterbury.

Along the South Downs are:

(*a*) The Arun Gap—Arundel.
(*b*) The Adur Gap—Steyning.
(*c*) The Ouse Gap—Lewes.
(*d*) The Cuckmere Gap.

Apart from the features associated with the normal scarplands there are morphological characters of great interest in the Weald in the presence of platforms, probably cut by the Pliocene—the last sea to occupy this part of Britain.

The London Basin.—The London Basin is both a geographical and a geological unit. Geologically, it is a broad synclinal basin

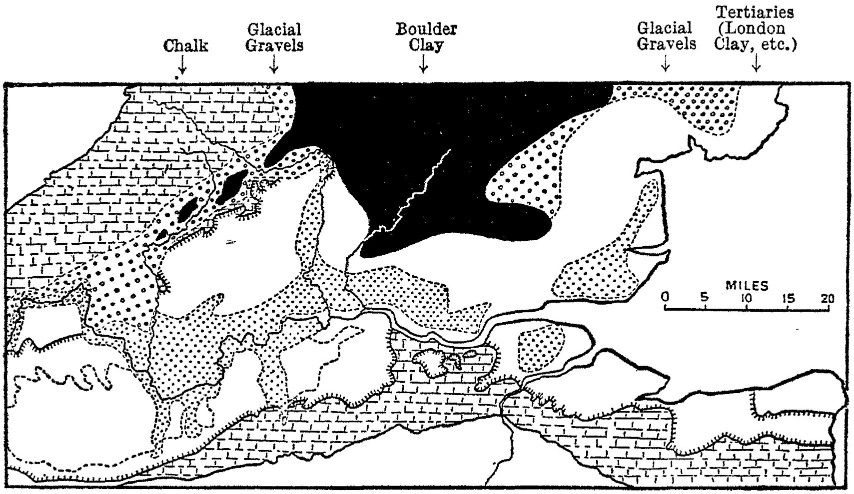


Fig. 42.—The geology of the London Basin (simplified).
Lightly dotted area = river gravels; for alluvium, see dotted area on Fig. 43.
(*After S. W. Wooldridge.*)

with a clearly defined chalk rim and a central portion occupied by sands and clays of the Tertiary sequence, by gravels of varied origin, and by alluvium. The chalk which underlies the London Basin in turn rests directly, or with but a small intervening thickness of older deposits, on the ancient Palæozoic platform which, like its analogues in South Wales or Northern France, is highly folded and fractured. It is probable that renewed movements along the folds

and fractures of the Palæozoic platform have been responsible for the existence in the London Basin of minor structures. The London Basin, a syncline as a whole, is not symmetrical. Its axis is towards the southern edge, and it is to be noted that it is along this line that the lower River Thames flows. Then there is quite an important fold in the centre with an east-west trend, sometimes known as the Thames Basin or the London Basin Anticline. These minor structures, combined with the very varied character of the young sedimentary rocks which fill in the basin, are responsible for its very varied morphological character. It has, accordingly,

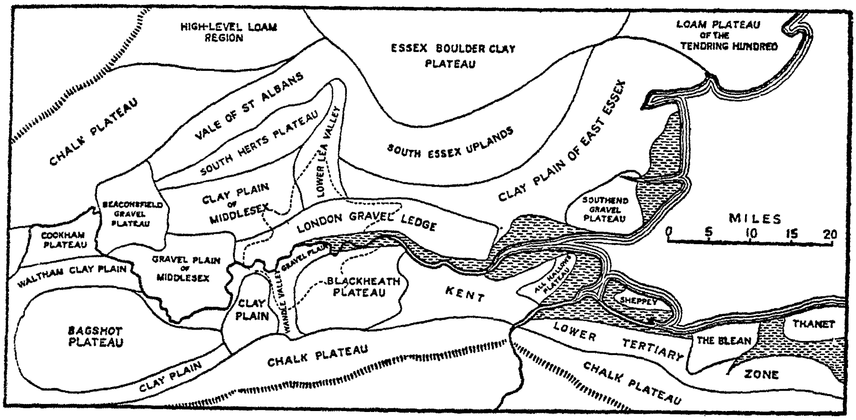


FIG. 43.—The minor physiographic regions of the London Basin, according to Dr. S. W. Wooldridge.

been divided into minor natural regions, mainly on a geo-morphological basis, by Dr. S. W. Wooldridge.[1] Two maps are here reproduced from Dr. Wooldridge's account, the one showing the position of the main drift deposits, and the other a suggested regional subdivision of the basin. These two maps must be left to speak for themselves. They should be used when studying in detail the position of London itself.

The Hampshire Basin.—In many ways the Hampshire Basin resembles the London Basin. There is a surrounding girdle of chalk downs and a central region of later clays and sands. Instead, however, of the basin being open to the sea to the east, its southern chalk rim has been cut through by the sea in two places—at each end of the Isle of Wight. Although strictly speaking the Hampshire Basin might be limited to the central area of Tertiary rocks, it is convenient to consider the surrounding area of chalk downs also in any general geographical consideration of the Basin. There is thus

[1] "The Physiographic Evolution of the London Basin," *Geography*, XVII, 1932, 99–116.

the Tertiary belt of the heart of the basin, and the surrounding chalk lands. As in the case of the London Basin, subsidiary folds occur, and one important one brings up the chalk to form the Portsdown Hills to the north of Portsmouth (see Fig. 44). The Tertiary belt differs from that of the London Basin in the rather larger proportion of coarse or mixed sands. These are especially important in the south-west, where the New Forest is found on sandy areas of this character. The more varied of the Tertiary rocks give rise to sandy and loamy soils suitable for mixed farming, and have a low but varied topography. The southern rim of the Hampshire Basin is formed by a sharp fold of chalk which cuts across the Isle of Wight, following its longer axis. To the south of this central ridge in the Isle of Wight there are early Cretaceous rocks, giving rise to

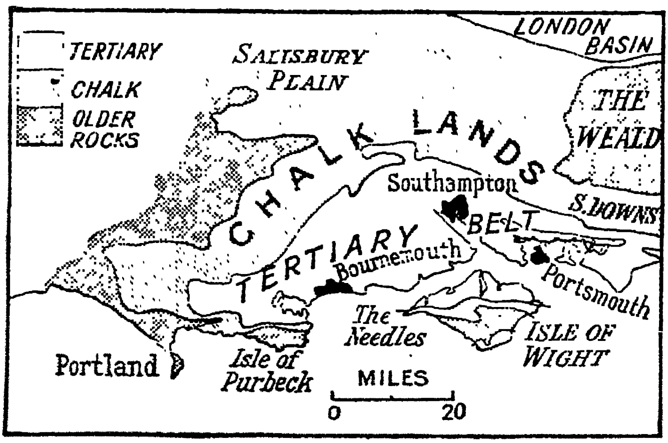


FIG. 44.—The Hampshire Basin.

varied country, repeating on a small scale some of the features of the Weald. In the so-called Isle of Purbeck still older rocks appear, and one sees part of the Jurassic sequence of the Jurassic scarplands.

East Anglia.—East Anglia corresponds roughly with the counties of Norfolk and Suffolk. Chalk underlies most of the western two-thirds of this tract and later Tertiary rocks the remainder, but the whole tends to be so thickly covered with glacial and other deposits that East Anglia is very far from resembling the well known chalk downland. At the present day it is difficult to realise the former isolation of East Anglia. It is bounded on the north and east by the sea. To the south it stretched as far as the once thickly forested damp lowlands of Essex; on the west lay the impassable marshes of the Fenlands, and it was only to the south-west that East Anglia could be approached along the comparatively

dry route afforded by the chalk country of the East Anglian Heights. Though the former isolation has disappeared, East Anglia remains a remarkable geographical entity. The character of East Anglia varies mainly according to the nature of its surface deposits. The whole is a low plateau with an undulating surface, often indeed almost flat, and in which those towns and villages situated along the river courses tend to be hidden, as, for example, in the case of Norwich. A special feature of interest is that area known as the Broads—wide stretches of shallow water, where the rivers have been ponded back by the formation of bars preventing the free flow of their waters to the North Sea. As East Anglia is mainly agricultural, its division into sub-regions will be considered relative to agriculture.

IRELAND

The geography and natural regions of Ireland have been reserved for special treatment in connection with agriculture (see Chapter XIII), but it may be noted here that its physiographic units connect very closely with those of England and Scotland. In the north-west there are masses of ancient metamorphic rocks which form a continuation of the Highlands of Scotland. In the north-east there is the natural continuation of the Southern Uplands of Scotland. Between the two there should be a western extension of the Midland Valley of Scotland, but this actually is obscured by the huge spread of lava which makes up the so-called Antrim Plateau, a saucer-shaped basalt plateau with the large but shallow Lough Neagh in the centre. The Mourne Mountains are formed by a mass of granite intruded into rocks which are a continuation of the Southern Uplands of Scotland. The south-east of Ireland is occupied by the Wexford Uplands and the Wicklow Mountains. Doubtless the Wexford Upland area was formerly continuous with the main mass of Wales with which it is geologically and structurally allied, whereas the Wicklow Mountains represent an enormous mass of granite, the largest in the British Isles. South-western Ireland is characterised by a succession of sandstone ridges and limestone valleys. The sandstone is mainly of Old Red Sandstone age, the limestone is the Carboniferous Limestone. The folding is Armorican ; the folds are not quite east and west, the general trend being from west-south-west to east-north-east. The heart of Ireland is occupied by a great plain—the Central Plain—represented on geological maps as consisting of an enormous mass of Carboniferous Limestone. Through this there appear isolated mountain masses consisting either of older rocks, which appear in the form of anticlinal masses from beneath the limestone, or which represent the remnants of younger rocks of Coal Measure age. Actually the Carboniferous Limestone in the heart of Ireland

is very rarely seen. It has been covered to a great depth, either by a mask of bog and peat or by sands, clays, and other deposits which were left behind during the retreat of the great ice sheet.

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The detailed study of the physiography and geo-morphology of the British Isles has not yet been fully undertaken on a uniform plan. There are, of course, innumerable accounts of the physical features of the islands on general lines, and incidental accounts of local details will be found especially in the Memoirs of the Geological Survey and the geological papers in the Quarterly Journal of the Geological Society and the Proceedings of the Geologists' Association. Amongst other papers of importance, with details of physiography, apart from those already cited, are the following :

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CHAPTER IV

BRITISH WEATHER AND CLIMATE[1]

THE variability of British weather has long been a byword and, as every holiday-maker knows, the most reliable of British weather prophets are apt to be misled, at least at times, in their attempts to forecast the coming weather. Until recently atmospheric conditions at, or near, the surface of the earth were those which most concerned its human inhabitants. With the coming of the aeroplane the conditions in the higher layers of the earth's atmosphere suddenly became of considerable importance. It was during the war especially that innumerable investigations had almost perforce to be carried out in the higher layers of the atmosphere in studying the behaviour of currents and the occurrence of " air pockets." It is largely as a result of these investigations, previously of interest mainly to the scientific meteorologist, that ideas concerning the causation of weather conditions have become fundamentally changed. The old dogmatic statements of the text-books can no longer be received, but at the same time it is not yet possible to state in simple terms, or with general assurance, the results of modern studies. The conceptions which are associated especially with the name of Bjerknes and the Norwegian school of meteorologists may be described as those now generally accepted.

A number of factors have a determining influence on the character of British weather and climate. The factors may be grouped as follows:

(a) The shores of the British Isles, more especially the western shores, are bathed by a warm drift of water, the North Atlantic Drift, which is a continuation of the Gulf Stream. The existence of this warm drift of water has undoubtedly an important effect in ameliorating winter conditions. To the north and north-east of the British Isles no land barrier exists to prevent the flow of water. It therefore makes its influence felt right along the coast of Norway to well within the Arctic Circle, with the result that even the Murmansk coast of northern Russia remains free from ice throughout the winter. The British Isles thus lie within the well known winter gulf of

[1] The authors are greatly indebted to Dr. J. Glasspoole, Secretary of the Royal Meteorological Society, for valued criticism and advice on this chapter, and to their colleague, Dr. S. W. Wooldridge, for further comments.

warmth and possess a milder climate than any other region in corresponding latitudes. They afford a remarkable contrast in this respect to lands such as Northern Japan or Labrador, which are situated on the eastern side of continental masses, and which are under the influence of cold ocean currents. It must be remembered that the direct effect of the warm waters themselves is much less important actually than the warmth which is communicated from the water to the prevalent south-westerly winds. The existence of the Continental Shelf round Britain enhances the influence of the waters in that they are spread out over a wide area and thus exert a maximum influence in warming the overlying air.

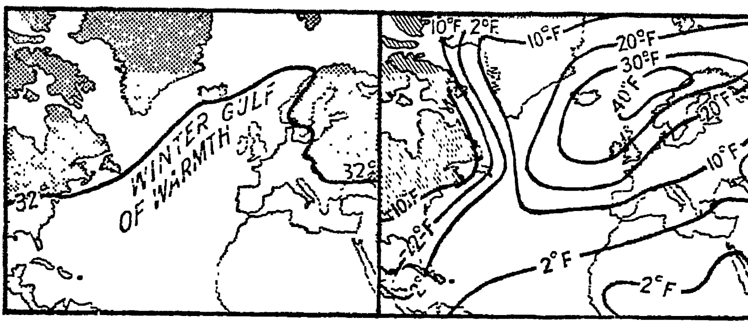


FIG. 45.—The figure on the left shows the " winter gulf of warmth " in which the British Isles lie. The isotherm shown is that of freezing point for January. The figure on the right expresses the same facts in terms of isanomalous lines. All parts heavily stippled are more than 20 degrees (F.) above the average for their latitude. Note the negative anomalies over eastern Canada.

(*b*) The British Isles lie wholly within the westerly wind belt or, to use the old expression, within the belt of the South-West Anti-Trade Winds.[1] There is not, of course, at any season of the year a constant westerly or south-westerly wind, although the south-westerly is the *dominant* wind in these islands. What is perhaps more important is the fact that the greater part of our weather comes from the south-west, that is from across the Atlantic. Thus British weather depends very largely on a series of whirls and eddies in the atmosphere (to which we give the name depressions, or " lows ") and intervening wedges of high pressure which move across these islands in a direction which is generally from the south-west. This is increasingly recognised, and the Meteorological Office now publishes a Daily

[1] Except perhaps in winter. If one accepts the Polar Front hypothesis (*vide infra*) it is probably correct to say that for periods during the winter the British Isles lie *within* the Front.

Weather Chart for the whole of the Northern Hemisphere, and by taking a series of these charts over a succession of days, it is often possible to trace the movements of the individual depressions across the Atlantic Ocean. On the other hand, any long range forecasting based on the weather experienced on the other side of the Atlantic is obviously liable to go wrong, since the depressions may become filled up and disappear in the course of their passage across the Atlantic or their path may lie to the north or to the south of the British Isles. The sequence of weather during the passage of a depression is well known, but changes in the rate of progression and in the intensity of depressions present considerable difficulties to the forecaster. Further reference will be made later to the character and causation of these depressions.

(c) The configuration of the British Isles, particularly the existence of numerous inlets, so that no part of the country is far from the sea, makes the penetration inland of oceanic influences more than would otherwise be the case. The existence of the principal hill masses of Britain on the western side of the islands, combined with the fact that the main rain-bearing winds blow from the south-west, results in a very marked difference in the amount of rainfall on the west and on the east. If it were not for this surface topography the whole of the British Isles would experience a moist climate, more like that of Ireland.

It will now be clear that the passage of depressions, or cyclones, over these islands has a dominating influence in determining the character of our daily weather. Thus the causation of these whirls in the air is a matter of some importance. According to the modern Norwegian school of Meteorology a very important difference is found between cold Polar air and warm air moving from the south-west, that is from equatorial or at least from tropical and sub-tropical regions. The position and the amount of the cold Polar air varies with the seasons, and this mass of cold heavy air may be regarded as having a front, or southern limit, known as the Polar Front, lying normally somewhere to the north of the British Isles, not infrequently at least in the neighbourhood of Iceland. It has

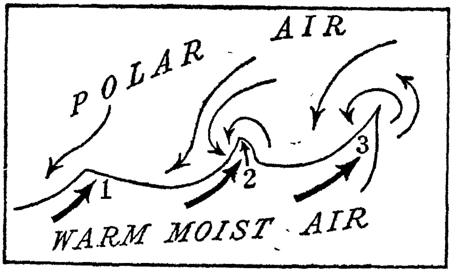


FIG. 46.—Diagram illustrating the Polar Front hypothesis of the formation of cyclones.

1 = an incipient cyclone; 2 = a mature cyclone; 3 = senile or post-mature cyclone.

been suggested in winter that the Polar Front may be regarded *very roughly* as following the 32° F. isotherm. It is the friction between the current of equatorial or warm air and the cold, almost stagnant, Polar air that is believed to give rise to the succession of cyclones which we associate with the Polar Front. The formation of cyclones on this hypothesis is best understood by reference to the diagram. It will be seen that a whirling motion of the air is set up in which the winds blow round a centre, actually a low pressure centre, in a counter-clockwise direction. Where the warm moisture-laden air meets the cold Polar Front condensation takes place, especially when the warm air is forced over the cold air. The indraught of cold air from the north which marks the passing of the cyclone is accompanied by a drop in temperature, but, after an initial cloudiness explained in Fig. 51, in a clearing of the sky. If one accepts this hypothesis of the formation of cyclones, the fact that the Polar Front is approximately over Iceland would result in a continuous succession of cyclones passing across Iceland in a north-easterly direction. If one takes an average of such conditions one gets the conception of a semi-permanent low pressure system situated approximately, as our weather reports say, off Iceland.

Before considering the weather conditions in the British Isles in particular, it will be necessary to look at the weather conditions affecting the whole of Europe, and it is simplest to do this by contrasting the winter and the summer conditions.

Winter conditions.—In the winter months the Continent of Europe lies in the belt of the westerly winds, warm moisture-laden winds from the Atlantic Ocean. The extra-tropical belt of high pressure at this season lies well to the south of the Continent—over the Sahara and its continuation into the Atlantic Ocean to the south of the Azores. Thus there is a high pressure area over the Azores and, as we have already seen, a semi-permanent low pressure system roughly over Iceland. But the eastern part of the Continent is very near the great land mass of central Asia, of which it is indeed a continuation, and so at this season gets extremely cold. One may picture a great mass of cold heavy air over Asia and eastern Europe, giving rise to a permanent high pressure system in the winter. The warm moisture-laden air from the Atlantic blows up against this, as against a wall, and either finds a way of escape to the north-east along the coast of Norway, or a way of escape to the south along the Mediterranean. At times this great high pressure system of eastern Europe, with its cold outblowing winds, may exert its influence even as far as the eastern shores of the British Isles and may therefore give rise to cold and frosty, though often sunny, weather. Indeed it may be said that the winter weather of the British Isles is determined by the relative strength

or importance of these three great pressure systems—the semi-permanent low pressure system over Iceland, the permanent high pressure system over eastern Europe, and the high pressure system south of the Azores. Bearing these facts in mind it is not difficult to understand why in the winter months it becomes steadily colder as one travels eastwards across the British Isles and, indeed, as one travels eastwards in Europe. In Europe we find that the isotherm of 32°, or freezing point, divides the Continent roughly into two halves and, as we have already noted above, we may look upon this isotherm as marking approximately the position at this season

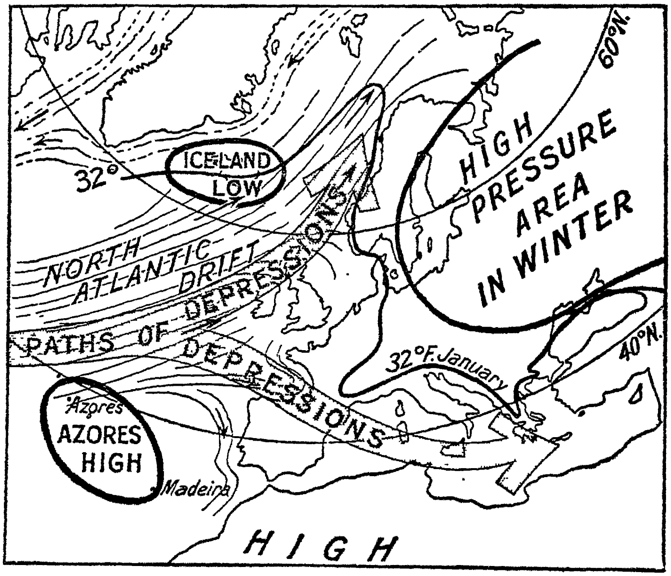


FIG. 47.—Generalised winter conditions.

of the Polar Front. Thus the cold mass of air over Russia and eastern Europe may be regarded as lying within the Polar Front. At this season the moisture-laden winds from the west deposit their moisture on the western sides of the land masses; they are unable to penetrate very far towards the east and so there is comparatively little precipitation in the east. This is apparent even in the British Isles, where in the western half of the islands more than half of the total rainfall comes in the winter months, whereas in the eastern half of the islands the greater rainfall is during the summer months (see Fig. 56).

Summer conditions.—At this season the wind systems of the world have moved to the north of their average position, so that only the northern part of Europe comes under the influence of the

westerly winds. The southern parts of Europe, that is to say the countries surrounding the Mediterranean Sea, lie within the influence of the high pressure belt which almost girdles the globe just outside the Tropics. The high pressure reigning in the summer months over the Mediterranean prevents the penetration of the cooling, or rain-bearing, winds from the Atlantic Ocean. Consequently the Mediterranean Lands suffer from considerable heat and comparative, or even complete, rainlessness. In the Atlantic the high pressure centre of the Azores, which forms part of this belt of high pressure, is north of its winter position and frequently

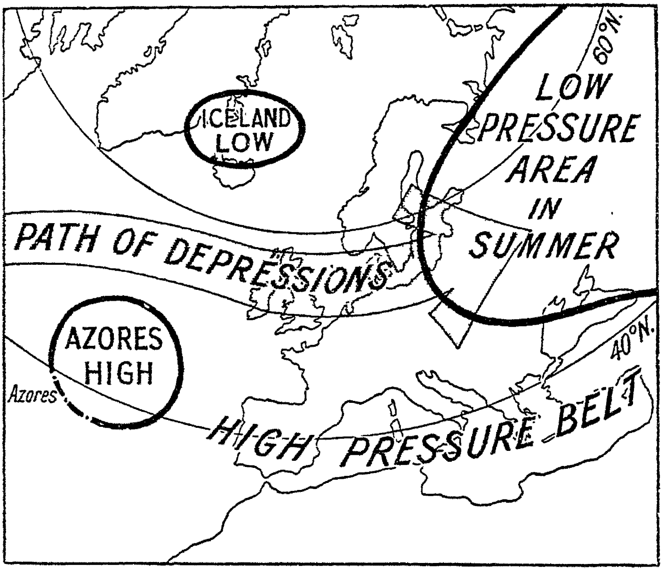


FIG. 48.—Generalised summer conditions.

extends its influence as far as the British Isles. On the other hand the Polar Front is further to the north and the belt of cyclones which is associated with it tends to be rather north of the island of Iceland and to affect the British Isles far less than in the winter. In eastern Europe the conditions of winter are reversed. The great Continental land mass is greatly heated and a large low pressure area is the result. There is a tendency for the low pressure to be particularly marked over southern Russia, and towards this area the rain-bearing winds from the Atlantic blow and result in the light spring rains of the steppelands of south-eastern Europe. Thus central and eastern Europe have the greater part of their rain, that is to say more than half the annual total, in the summer half of the year rather than in the winter.

It needs but a glance at a map of Europe to realise that the British Isles tend to be centrally situated between the three main pressure systems, and actually our weather, both in winter and summer, is largely determined by their relative strength. In winter there is a distinct tendency for the low pressure system over Iceland to be the most potent in determining the weather of these islands, except in those years when the high pressure system over eastern Europe is exceptionally strong and extends its influence as far as the east coasts of Scotland and England. For example, in the winter of 1928–9, when settled cold weather prevailed for long periods at a time, with cold easterly or north-easterly winds, it was found that the pressure system of eastern Europe was extending its influence as far as these islands. It should be noticed that when one of the high pressure systems extends its influence in this way there is a distinct tendency for the weather to remain settled for considerable periods of time. Thus in summer, when the high pressure system of the Azores stretches rather north of its normal position, there is a possibility that at least the south of England will enjoy long spells of fine weather. This happened in the summer of 1921,[1] again in 1929, and in the summer of 1931. These summers were marked, during the months of August and September, by fine and hot weather over the whole of the southern three-quarters of the islands; but in 1929 in particular the summer was marked in northern Scotland by an extended period of bad weather: in other words, the path of the cyclones from the Atlantic lay along the northern fringe of the high pressure system which remained comparatively stable over southern Britain.

So far we have considered only the three great pressure systems which are dominant factors in determining European weather, but actually the weather in these islands is determined to an even greater extent by the passage of a succession of secondary depressions, or secondary cyclones, with intervening ridges of high pressure. Since the British Isles are intermediately placed between the three great pressure systems of Europe both in summer and in winter, it follows that the line of passage of these secondary depressions must lie across these islands in both seasons of the year. Since this is the case it is desirable to examine in a little more detail the succession of weather which results. One must remember that a cyclone or depression in the Northern Hemisphere is marked by a low pressure centre with upward currents of air. Winds tend to blow round this centre, for reasons which have already been explained, in an anti-clockwise direction, and at the same time towards the centre where they rise. When a depression, therefore, is approaching these islands from the Atlantic the barometer will fall and

[1] *Quart. Jour. Roy. Met. Soc.*, XLVIII, 1922, 139–168 (dealing with droughts in general).

winds will be southerly to south-westerly, veering westerly later. Coming from the Atlantic, they will be warm and moisture-laden, blowing northwards towards cooler regions and also towards the central depression where they will rise, rain begins to fall. Where the oncoming warm south-westerly winds meet the colder air, the "warm front," as it is called, is formed and along this warm front, where the air is cooled by rising over the cold air, rain is likely to occur, and prolonged steady rain may result. Subsequently there is usually a break in the weather. After the centre of the depression has passed across the islands, usually in a normally easterly, or north-easterly, direction, the barometer will again rise and the normal air currents will now be the colder winds from the

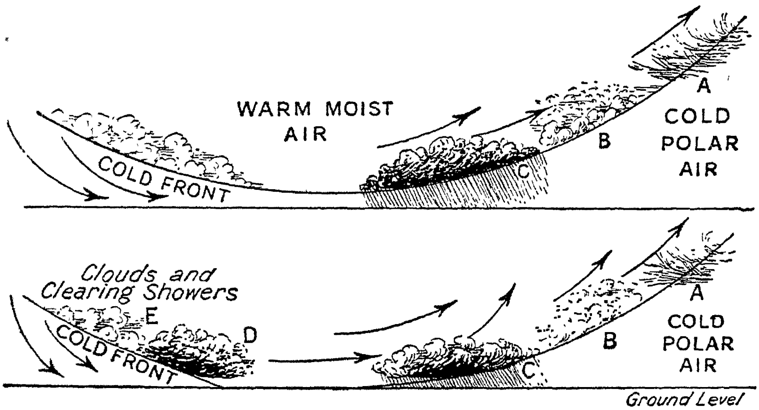


FIG. 51.—Sections through a typical cyclone.

A, cirrus clouds indicating the approach of the depression. B, cumulus clouds followed by C, nimbus clouds with heavy rain. The "eye" of the storm is succeeded by cumulo-nimbus clouds (D) and cumulus clouds E, accompanied by clearing showers.

north or north-west. These winds are comparatively dry, but where they impinge on the flanks of the south-westerly current intense rain with squalls may result. This is shown in the diagram. Actually the diagram illustrates a cyclone probably along the Polar Front itself, but the passage of a smaller secondary depression across the islands would produce comparable weather conditions. The passage of such a small depression is often, one might say usually, followed by the passage of a ridge of high pressure, ushered in by the continuation of the cool northerly winds and a steadily rising barometer. Fine sunny weather may result in the summer, but as the winds decrease and calm conditions prevail the passage of such a ridge of high pressure is often marred in winter by the occurrence of fogs.

In the analysis of the general conditions in Europe we referred to the formation of a great high pressure centre over eastern

Europe in winter and the formation of a low pressure centre over the same area in summer. Naturally there must be two seasons of the year when the change from one to the other takes place, and it is very largely the resulting disturbance of atmospheric conditions which is responsible for the well known equinoctial gales

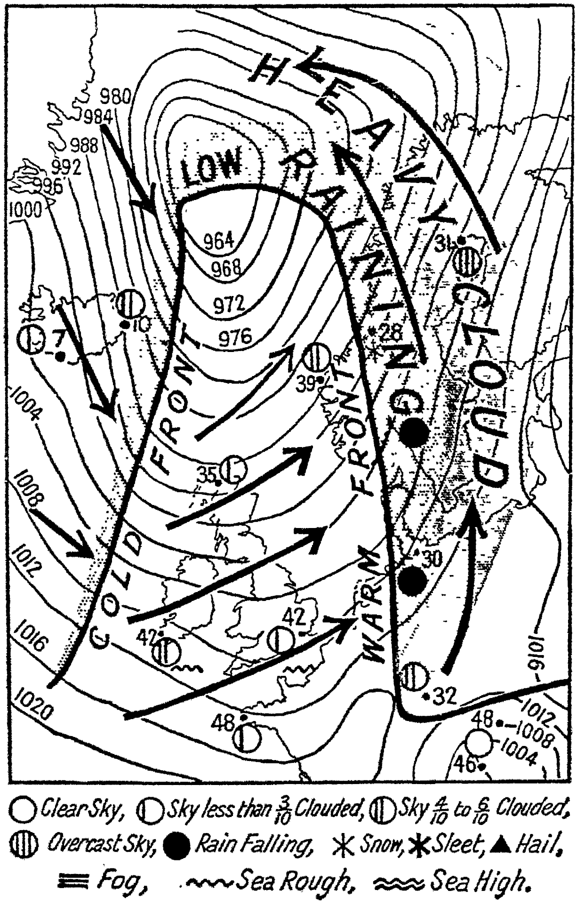


Fig. 52.—A cyclone or depression over the British Isles, showing the symbols used on weather charts. This chart interprets the *observed* weather conditions according to the Polar Front hypothesis. Large figures are temperatures in degrees Fahrenheit.

experienced in this country. Whilst in the early part of the year high winds are associated with the month of March and the fame of March winds is perpetuated in many a nursery rhyme and popular ballad, the change indicated by these winds does not always take place at exactly the same time. In some years March

may "come in like the lion and go out like the lamb," in others it may come in like the lamb when the winter conditions still prevail, but go out like the lion. The corresponding high winds associated with the disturbances at the autumnal equinox are the equinoctial gales of September and October. After the equinoctial gales of March come the still unsettled conditions of April, when numerous small secondary disturbances result in April showers. The small rainfall of the early spring months can be correlated with the small evaporation. Indeed, evaporation is almost confined to the six months April to September. There is a definite lag between

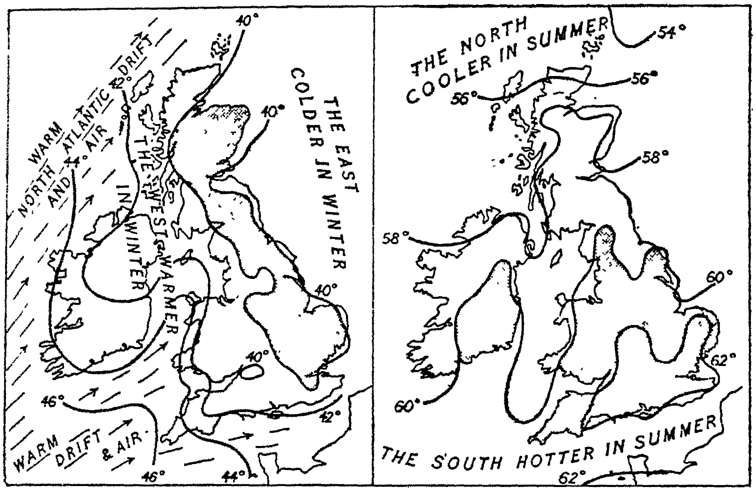


FIG. 53.—Temperature conditions in January (1906–1935).

Isotherms in degrees Fahrenheit.

FIG. 54.—Temperature conditions in July (1906–1935).

Isotherms in degrees Fahrenheit.

Mean temperatures reduced to sea-level (*after E. G. Bilham*).

the increase of evaporation in April and the increase in the mean rainfall per rain-day which does not exceed the average for the year until July. Similarly the mean rainfall per rain-day continues above the average for the year for some three months after the evaporation has practically ceased at the end of September.

So far we have been dealing with the weather conditions of the British Isles, and owing to the irregular succession of weather it is sometimes said that the British Isles have no climate, since climate is described as the average state of the weather. This may at least serve as a useful reminder that we should use the averages mentioned in the paragraph below with care owing to the variability from year to year, and even during one year. Taking, first, tem-

perature conditions in the winter, it may be said that in general conditions in the British Isles reflect in detail those prevailing in Europe as a whole. In winter the west is warmer than the east and the isotherm of 40 degrees in January roughly divides the islands into two and its curve should be carefully noted. As one would expect at this season, the extreme south-west of Britain and south-western Ireland are, taking the average conditions in January, the warmest parts of the islands. The Scilly Isles have an average temperature in January of no less than 45 degrees, whilst snow and frost are both rare. The important effects which this has on the products which are possible in these areas, and on the use of warmer parts of Britain in winter as winter resorts, may be mentioned. Taking the evidence afforded by the isotherms alone the coldest parts in the British Isles in winter are certain tracts down the east coast, and it would seem that the east coast of Scotland in the neighbourhood of Aberdeen is not as cold as some parts of the coast of East Anglia further south, but the ordinary dry-bulb thermometer is scarcely an adequate measure of temperature in so far as it affects human beings and there is perhaps a rawer quality in the air in northern tracts. In summer, by way of contrast, the south of the British Isles is warmer than the north. The isotherm of 60 degrees in July runs roughly from east to west. The south-east quarter is the warmest of all in July in the neighbourhood of London, but the average along the south coast is high. The coolest parts of the islands at this season of the year are the extreme north of Scotland, the Orkneys and the Shetlands. Though geographers have long been accustomed—perhaps too slavishly—to take January and July as the typical winter and summer months, they are not in the British Isles the coldest and warmest months respectively. It frequently happens in oceanic

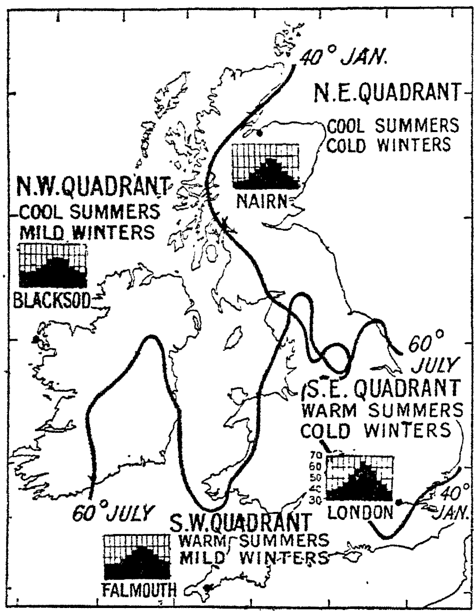


Fig. 55.—The four quadrants of the British Isles.

or insular climates that there is a considerable lag between the period when the sun's rays strike least obliquely or most obliquely on the surface of the ground and the time when the highest and lowest average temperatures are reached, so that for many parts of the British Isles February is the coldest month and usually August the hottest month. Even, however, taking January and

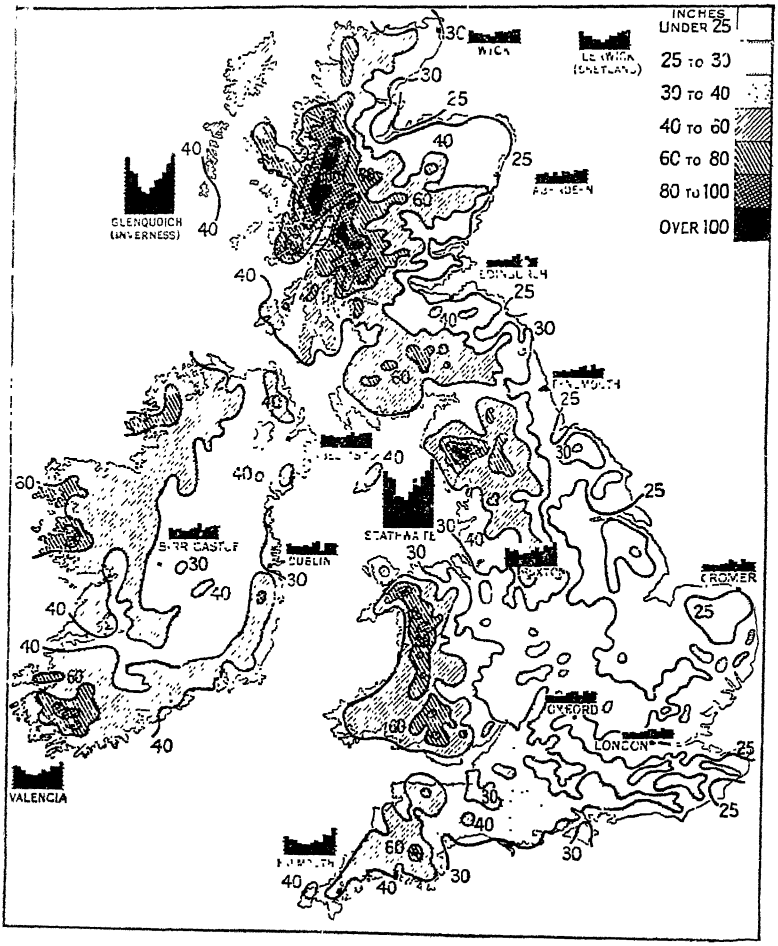


FIG. 56.—An Annual Rainfall Map of the British Isles.

July and noticing the course of the isotherms across the islands, it will be seen that the 40-degree isotherm for January and the 60-degree isotherm for July divide the islands roughly into four quarters. The north-west quadrant is the most "oceanic," and it is possible to find stations in the Outer Hebrides which have a

range of only 56–43 (= 13 degrees) between the winter months and the summer months. The south-east quadrant is the most nearly "continental," if that adjective can be applied at all to any part of the British Isles. Nevertheless, the temperature range of London is from 64 to 38 degrees—no less than 26 degrees—quite a remarkable contrast to the stations just mentioned.

Turning now to the rainfall of the British Isles, a map has been prepared, together with rainfall graphs showing the distribution of rainfall in the different months of the year. These indicate certain important points: the first is the well distributed rainfall throughout the year, characteristic of the British Isles; the second is the general tendency for stations on the west to receive the greater part of their precipitation in the winter, while further east the greater proportion of the rainfall occurs in the summer half of the year. The third is that in general there is an autumn

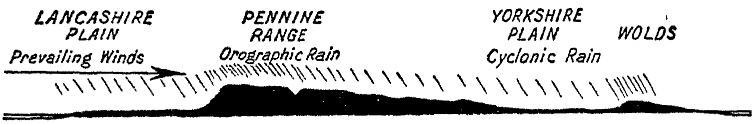


FIG. 57.—Section across the north of England.

maximum, usually reached in October, extending roughly for the period of the equinoctial gales.

Then the map illustrates quite clearly the general broad distinction between the drier east and the wetter west, with the areas of heaviest rainfall—more than 60 inches—on the upland and highland areas, particularly of Scotland, the Lake District, the Pennines, Wales and western Ireland. The average annual rainfall is about 20 inches in the neighbourhood of the Thames estuary and probably reaches 200 inches over small areas in the Western Highlands, at the head of the river Garry and on Snowdon. This suggests at once that the rainfall of the British Isles is mainly orographical, but if it were entirely orographical, then the east, of course, would be much drier than is actually the case. In reality the rainfall of the British Isles is partly orographical—due to the relief of the islands—partly cyclonic and, in a smaller degree, brought by thunderstorms.[1] It may be said at once that the rainfall in all parts of the British islands is adequate for agricultural purposes and, in many of the more hilly regions, the rainfall must actually be classed from this point of view as excessive. The

[1] The effect of "continentality" is apparent, for the annual totals of rainfall when expressed as percentages of the average annual rainfall are more than twice as variable in central districts of England than along the extreme north-west of Ireland. See C. S. Salter, *The Rainfall of the British Isles*.

coasts of Ireland, western Scotland, and many parts of western England and Wales receive too much moisture to make farming possible or at least profitable. A severe limitation is applied by excessive moisture on crops which can be grown by the arable farmer, and it is not too much to say that farming of all types may be prevented in certain areas. Further consideration will be given

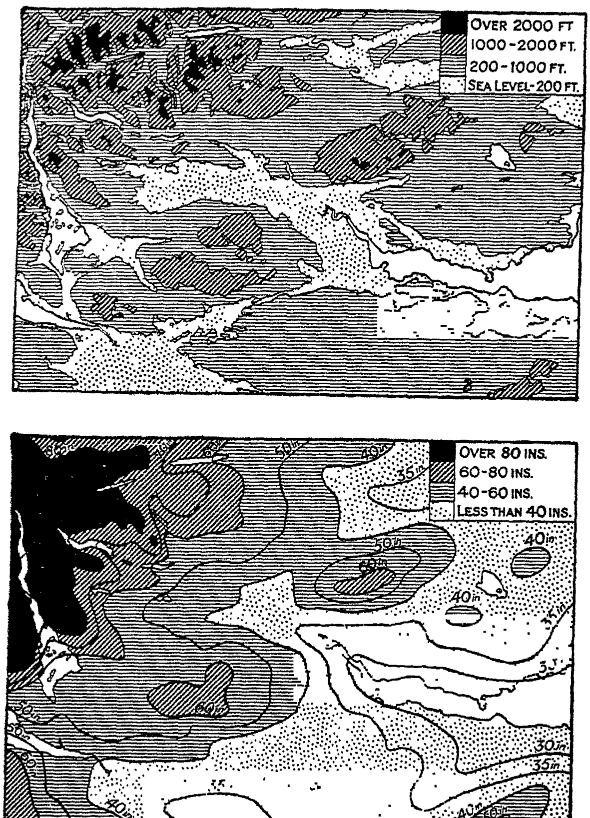


FIG. 58.—The correlation between topography and rainfall in the Midland Valley of Scotland. (*After H. R. Mill.*)

to this question later, but it may be said that cereal farming, with the exception of the cultivation of that hardy crop—oats, is largely restricted to the regions having less than 30 inches of rain per year. It has, indeed, been suggested that England can be divided into four agricultural provinces by using the 60-degree July isotherm and the 30-inch rainfall line, since the 60-degree isotherm marks

the approximate northern *economic* limit of the cultivation of certain crops (*e.g.* wheat).

Rainfall by itself is not, of course, an adequate measure of the relative wetness or dryness of a country from the agricultural point of view, but with cloudy skies and comparatively low temperatures throughout the year evaporation is relatively small [1]; long periods

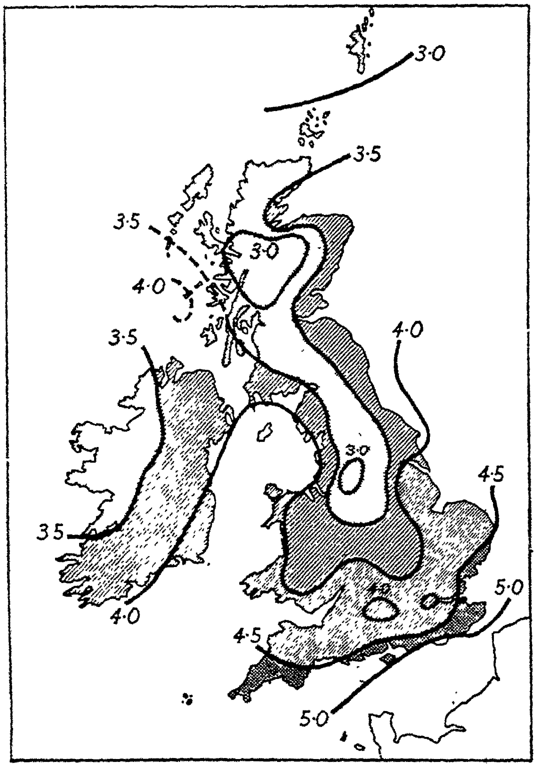


FIG. 59.—Sunshine map of the British Isles, showing the average number of hours of sunshine per day throughout the year (1906–35). *After E. G. Bilham.*

of drought are unknown. Further, the variability of British rainfall from one year to another is comparatively slight; it is rare for any part to experience more than 160 per cent. or less than 50 per cent. of the average. There are occasions when the British

[1] Evaporation from exposed water surfaces varies but little in the British Isles, and is about 14 to 17 inches per annum.

farmer, robbed of showers of rain at just the seasons when he considers his crops require moisture, complains of drought; but the British Isles may be said never to suffer from drought in the way in which that scourge may affect such an area as Australia. The difference in moisture conditions between the western and eastern sides of Britain is perhaps greater than would appear from merely an examination of rainfall figures. Since the largest proportion of the rain on the eastern side is cyclonic in character, periods of heavy rain tend to be separated by days when rainfall is practically nil. On the other hand, in the west, particularly in Ireland, there is a much greater tendency for a succession of days of light drizzle. It is a common greeting in Ireland for one farmer to say to another, "Fine soft day to-day," meaning a day characterised by warm gentle drizzle. The average number of days with rain increases very steadily from the south-east to the north-west of the British Isles. This is due to the greater frequency of depressions to the north of these islands. Unlike the actual quantity of rainfall, geographical position is of more importance than altitude in determining the number of days with rain.

Some measure of this difference is afforded by the accompanying sunshine maps of the British Isles. Fig. 59 illustrates the advantages of situation along the south coast and along the east coast, and in lowland areas some distance from mountains which attract cloud. There is a general tendency, too, for a larger proportion of winter sunshine in the south, one reason being because of the longer winter days. It must not be forgotten that the northernmost part of Britain is sufficiently near the Arctic Circle for the summer nights to pass without complete darkness being reached, at least that is the case in the Shetland Islands in the latter part of June and July, when it is said to be possible to read by the twilight. It is of some interest to note the way in which the great British railway companies have seized upon salient facts of British climate for advertisement purposes. Thus the slogan of the Southern Railway is "South for Sunshine," and it is said to be necessary only to ask Sunny South Sam what to do for that smiling and ubiquitous railway servant to give full directions in the search for sunshine. The London and North Eastern Railway advertises its services to the "drier side" of Britain, which in turn is equally true. It may, however, be mentioned that the west coast scores in that slightly more rain falls at night than during the day, while along the east coast slightly more rain falls during the day than at night, the east coast districts experiencing thunderstorms during the late afternoon rather more frequently. The fame of the mild winters of the Mediterranean coast of France, or the French Riviera, was doubtless responsible for the application of the name "Cornish Riviera" to the coast of Cornwall. Everyone knows the Cornish

Riviera express of the Great Western Railway; a few years ago a widely used poster on that railway showed the Cornish peninsula on one side pointing to the south-west and the Italian peninsula on the other side pointing to the south-east, intending to suggest, of course, the similarity between the two. It is interesting to note that if one takes just the temperature records of coastal towns there is little difference between those of Cornwall and those of the French Riviera. For example, the mean January temperature of Penzance is 44 degrees, the January temperature of Nice is 46 degrees. The main difference comes in the sunshine records of 25 per cent. of the possible for the months of December, January and February for Penzance and over 50 per cent. for the same months for Nice.

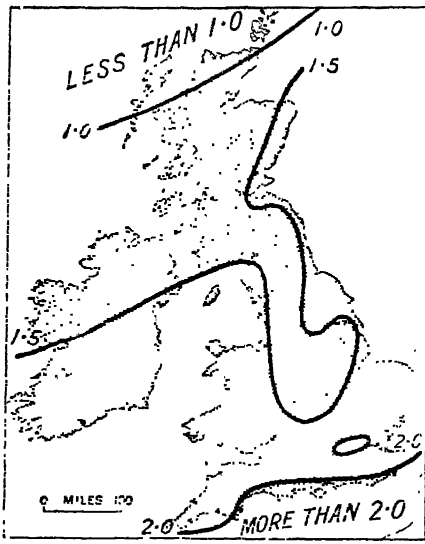


FIG. 60.—January sunshine, expressed in number of hours per day.

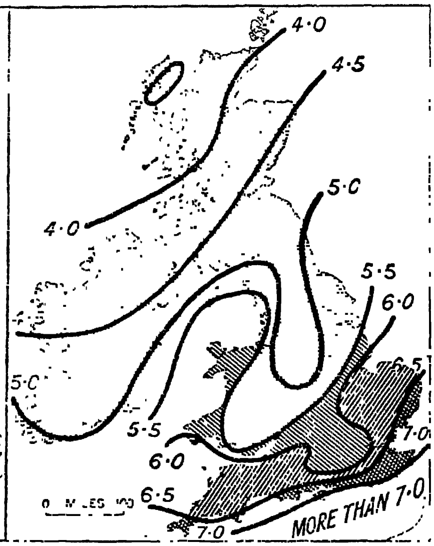


FIG. 61.—August sunshine—the number of hours per day in the chief "holiday month."

Even so the figures are sufficient to explain the reason why one should find such warmth-loving plants as the palm and the *Yucca* growing outdoors in the sheltered Cornish resorts and why they should justify their existence as winter resorts for invalids. Torquay, more accessible and developed with the amenities of a winter resort, has a January temperature of 42·3 degrees and a sunshine record for that month of 2 hours per day.

At least abroad, the British Isles have a reputation for fog, in very large measure undeserved. The old "pea-soup" fogs of London and other great towns were, of course, connected with the excessive use of imperfectly combusted coal and the humidity of the atmosphere: furthermore, the additional heat resulting from the

increasing number of houses, etc., has tended to disperse the fog at the level of the streets in recent years. Thus instead of dense fogs at ground level we have "high" fogs only. The days when Sherlock Holmes and his friend Dr. Watson contemplated the fire in a Baker Street flat while the impenetrable fog remained outside have doubtless gone for ever. An attempt has been made, in the table adjoining, to show the number of foggy days in parts of the British Isles. Settled anti-cyclonic conditions in the winter are the most dangerous period. Sea mists, driving up the Channel, are most important, these being caused, of course, by the slight movements of damp, moist air reaching the colder air over Britain itself. Fog, or sea mist, of this sort is not infrequently responsible for delaying ocean vessels and was directly responsible for the discontinuance of a very useful way of crossing from Britain to the Continent—from Tilbury to Dunkirk (Dunkerque).

NUMBER OF DAYS PER YEAR ON WHICH FOG IS NORMALLY RECORDED (DATA FROM OFFICIAL PILOTS' MANUALS)

Falmouth	10	Yarmouth	43	Malin Head	16
Plymouth	30	Hull	30	Valentia	5
Portsmouth	11	Scarborough	46	Cork Harbour	18
Dungeness	38	Tynemouth	39	Donaghadee	6
Dover	17	Leith	14	Glasgow	9
Margate	11	Aberdeen	18	Liverpool	18
Shoeburyness	42	Wick	21	Pembroke	45
Greenwich	46	Stornoway	5		

London, Greenwich :—Jan. 7; Feb. 4; Mar. 3; Apr. 1·5; May 0·5; June 0·8; July 0·1; Aug. 0·7; Sept. 4; Oct. 7; Nov. 10; Dec. 7.

Calculating the average duration of the fog at 4 hours on each day recorded, nowhere at the stations shown would fog occur during more than 2 per cent. of the year, *i.e.* 98 per cent. of the year is fog-free at the worst stations and 99·7 per cent. at the best. Including sea mist, some stations, it should be noted, may be only 85 per cent. mist-free.

In the section on temperature nothing was said about the effect of elevation in different parts of the British Isles in the determination of temperature, but the map of the average surface temperatures for the month of January shows at once the great influence which elevation exerts and affords the justification for regarding the Highlands of Scotland in January as the coldest part of the country, in contrast to what has already been said when isotherms are considered. This factor is readily apparent when snowfall is considered. Whilst in the south-west of the country—in Devon and Cornwall—snow rarely falls to lie at sea level, it is commonly seen, often for days together, on Dartmoor and such elevated tracts. In the determination of local variations in climate in different parts of the British Isles, aspect plays a part much greater than is often suspected. If one attempts to determine the upper limit of cultivation in such areas as the Pennines one finds that cultivation is almost invariably

carried to a higher level on the northern sides of valleys, that is to say those facing towards the south and the sun, than it is on the southern side. East-west hills often afford remarkable protection from cold northerly or north-easterly winds. The attraction of Ventnor, on the southern side of the Isle of Wight, is very largely due to the protection of the town from northerly winds by the high chalk downs which lie immediately behind. The early cultivation of tomatoes along a strip of the Sussex coast, in the neighbourhood of Worthing, is in large measure due to the pro-

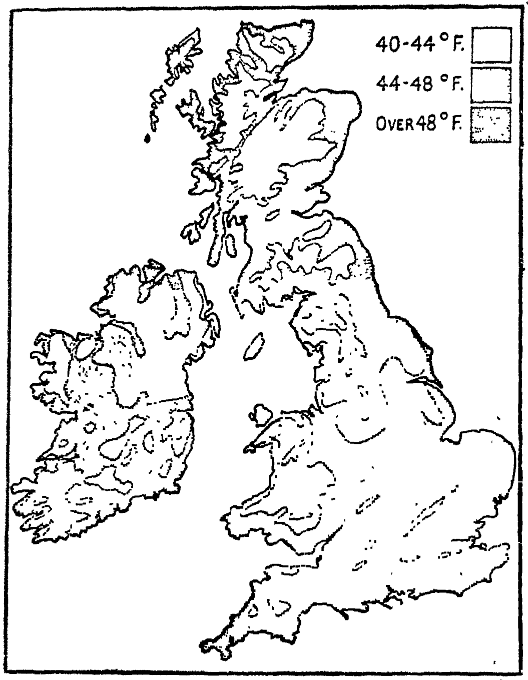
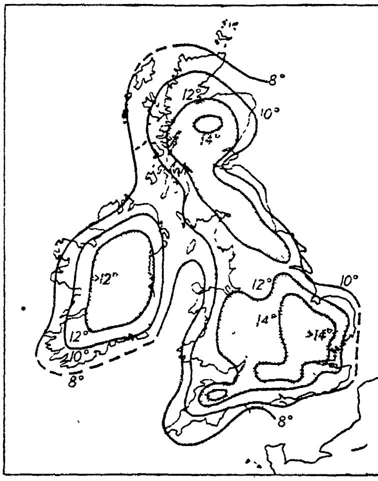


FIG. 62.—Map of the British Isles showing actual recorded surface temperatures (average for the whole year) illustrating the effects of elevation.

tection afforded by the South Downs in the immediate hinterland. The delightful mildness of Aberystwyth, which is important to the town as a resort, is again in large measure due to the protection by the Welsh hills behind. By way of contrast some of these sheltered resorts are described as enervating by those who prefer the more bracing conditions from the vigorous winds of the east coast in the winter.

It should be noted that references have been to *average* temperatures. Considerable importance must be attached to temperature ranges and average daily and annual ranges are shown in Figs. 62*a*

and 62*b*. Absolute maxima not infrequently exceed 90° F. in summer, but more important are the absolute minima in winter. Though rare, there are several records of 0° F., and such very low temperatures as occurred in the long cold spell of the winter of 1939–40 are important in that many plants normally hardy, failed to survive. A good example was the widespread destruction of the Californian *Cupressus macrocarpa*.



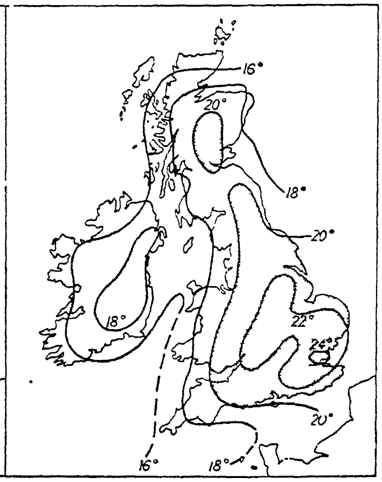


Fig. 62*a*.—Mean daily range of temperature (whole year): (1906–1935).

Fig. 62*b*.—Mean annual range of temperature (1921–1935).

Both these maps are after E. G. Bilham and clearly illustrate the moderating influence of the sea in lowering the range of temperature both diurnal and annual, whilst Fig. 62*b* illustrates the relative continentality of south-eastern England.

It remains to say a few words about the incidence of frost in the British Isles. The table shows the average number of days with ground frost at a number of selected stations:

Normal Number of Days with Ground Frost

Station	Height	J	F	M	A	M	J	J	A	S	O	N	D	Year	Days with snow
Balmoral . .	930	23	21	21	17	9	3	2	1	5	10	18	21	151	50
Glasgow . .	180	12	10	11	8	3	1	0	0	4	8	10	12	79	16
Birmingham .	535	17	15	15	11	5	1	0	1	3	7	14	13	102	—
London . .	18	15	15	15	13	4	1	0	0	2	8	14	14	101	13
Clacton . .	54	12	13	11	7	1	0	0	0	0	1	7	9	61	16
Liverpool . .	188	14	14	18	9	1	0	0	0	0	1	10	13	79	11
Falmouth . .	167	8	8	10	5	0	0	0	0	0	1	6	9	48	5
Guernsey . .	295	6	6	5	3	0	0	0	0	0	0	3	4	27	—

Variations in British Climate

There is a widespread belief that the climate of the British Isles is changing, and people are fond of stating that we do not get as severe winters now as occurred in the days of our forefathers ; and they point out that it is now no longer possible to roast an ox on the ice of the Thames frozen over. In this particular example, as in so many others, the full facts of the case are not taken into consideration. If the Thames of the present day were allowed to flow almost unrestricted through banks very wide apart, it would doubtless freeze over just as easily now as it did of old. Some authors have been at great pains to collect accurate information, and it would seem that the weather of the British Isles does tend to occur in cycles, and a correlation may perhaps be possible between these cycles of weather and the occurrence of sun-spots. C. E. P. Brooks, in his book on the *Evolution of Climate*, has collected the information available ; it would seem that there may be both major and minor cycles of weather. At the same time it is, of course, important to remember that in the early days of man's habitation of Britain, the country was under the influence of the great Ice Age, and there has, *on the whole*, been a steady change from that time to the present, with an increase in temperature and a decrease in humidity, though there is evidence for relatively wet or " pluvial " periods in Neolithic and Roman times interrupting the general change in an inter-glacial period, and evidence is rather lacking as to whether the climate as a whole is still getting milder or not. Climatic fluctuations since the disappearance of ice from Britain have played a major part in the development of the present flora and fauna and the following table is based on one in Tansley's *British Islands and Their Vegetation* (1939).

c. A.D. 500–1900	Recent	? Warmer and drier.	
c. B.C. 800–A.D. 500	Subatlantic	Cool and wet	Formation of *Sphagnum* peat. ? spread of beech. Iron Age.
c. B.C. 3000–800	Subboreal	Drier	Increase of pine and yew, entry of beech. Neolithic and Bronze Ages.
c. B.C. 5500–3000	Atlantic	Warm and wet	Oak forest dominant. Mesolithic Age.
c. B.C. 7500–5500	Boreal	Warm and dry	Birch and then pine dominant.
c. B.C. 8500–7500	Preboreal	Fluctuations	Birch and pine.
c. B.C. 18000–8500	Subarctic	Cold and dry	*Dryas* vegetation. Palæolithic Age.

It is probable that these climatic fluctuations are intimately connected with the final separation of Britain from the continent, and the establishment of the present oceanic circulation. The climatic periods in Britain are not necessarily contemporary with those established on the continent. This is discussed by L. D. Stamp, *The Evolution of the North Sea Basin* (Copenhagen, *Soc. pour l'Expl. de la mer*, 1938).

Phenology.—An important aspect of applied climatology is the relationship of climate and the growing season of plants. It is well known that the incidence of spring is earlier in the south-west than in other parts of the British Isles and it has been possible, by recording the dates of first observed flowering of a number of widely distributed plants, to construct maps showing the relative dates of the coming of spring over the whole country. These phenological studies have an obviously important bearing on agricultural practice.

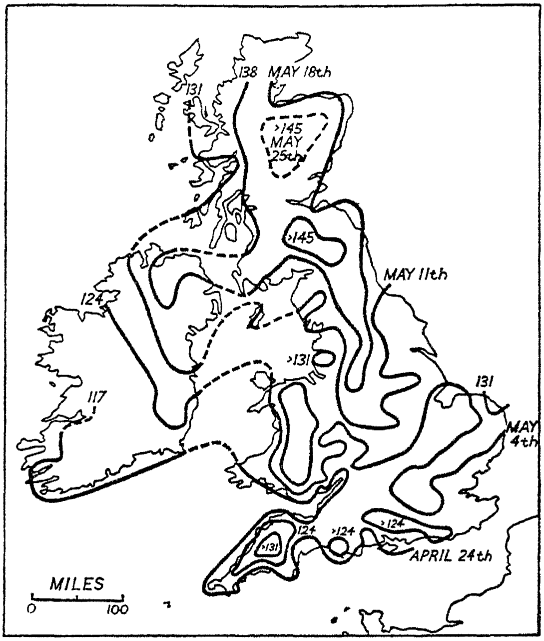


Fig. 63.—Phenological map of the British Isles.
Showing the average dates of flowering of fourteen selected plants.

REFERENCES

Daily Weather Chart and Report, issued by the Meteorological Office of the Air Ministry. The essential features of these are included in the principal daily papers. The Meteorological Office also publishes daily a Weather Chart for the whole of the Northern Hemisphere. This chart is particularly instructive in attempting to predict changes of weather for the ensuing week. Rainfall records have been collected by the British Rainfall Organisation since about 1860, and some records do exist going back to 1677. This was for many years a voluntary organisation under the personal control of G. J. Symons and later Dr. H. R. Mill. About 1920 the Meteorological Office took over the work, but the observers still maintain observations in various parts of the country mainly for their own interest. The organisation encourages observers to take observations on a uniform basis with standard instruments and publishes the results in an annual volume entitled *British Rainfall*, which also deals with special features of the incidence of the rainfall for the year in question. Collected figures for rainfall, temperature, sunshine, etc., will be found in the *Book of Normals* published by the Stationery Office.

Since the above account was written E. G. Bilham's *The Climate of the British Isles* (London, Macmillan, 1938) has been published and is now the standard work. There are also several books which deal more generally with modern aspects of meteorology. An example is :

R. G. K. Lempfert : *Meteorology*. London, Methuen, 1920.

Sections on the climate of each county of Britain are published in the separate parts of *The Land of Britain* (London : Land Utilisation Survey, London School of Economics) and in nearly all cases there is a detailed rainfall map.

See also :

Rainfall Atlas of the British Isles, published by the Royal Meteorological Society.
The Monthly Weather Report, published by the Stationery Office.
G. Manley : " On the occurrence of Snow cover in Great Britain," *Q. J. R. Met. Soc.*, LXV, 1939, 2–27.

CHAPTER V

THE INLAND WATERS OF THE BRITISH ISLES

Of the rain that falls on the surface of the British Isles, part evaporates,[1] part soaks into the ground, and part, usually a large part, runs off to form streams and rivulets, and eventually finds its way into the rivers of the country. That which percolates into the soil and into the rocks of the earth's crust is in part utilised by plants growing therein, and may eventually pass back into the atmosphere; but some of this water joins the underground water table and becomes part of an underground supply, being gradually returned to the open where the water table comes to the surface, and the water thereupon re-issues in the form of springs. It is not the purpose of this chapter to study the behaviour of underground water, or even of surface streams; but to regard the sum total of rain falling upon the surface of the British Isles as one of the natural resources of this country, and to study its utilisation.

The Evolution of British Rivers

The evolution of the existing British river system falls into three phases:

(*a*) the pre-glacial phase;
(*b*) the period of glacial interference;
(*c*) the period of man's interference.

It is certain that the main lines of the present topography of the British Isles were outlined before the coming of the great Ice Age. On the whole, many of the rivers must have followed substantially their present courses. In England and Wales, it is probable that the Highland Zone on the north and west of the country exercised a greater influence than it does at the present day, and that there were many rivers draining from the higher lands of Wales, or the north of England, following the general slope of the land towards the south-east (see Fig. 13). The tectonic depression of the Thames Basin considerably ante-dates the glacial period, and

[1] Taken throughout the year evaporation does not vary very widely from one part of the British Isles to another. From exposed surfaces of water (*e.g.* lakes and reservoirs) it is equivalent to about 14 to 17 inches of rainfall. Thus in areas with a rainfall of 25 to 60 inches from 30 to 60 per cent. (over large areas between 40 to 50 per cent.) of the rainfall is lost by evaporation. This takes into consideration the greatly varying evaporation from land surfaces.

it is likely that these south-easterly flowing rivers made their way into what may be called the proto-Thames. The extreme south-east of England—the Wealden area—is the classic area in the study of river development, mentioned above. The coming of the great Ice Age and the formation of huge ice sheets over the north of the

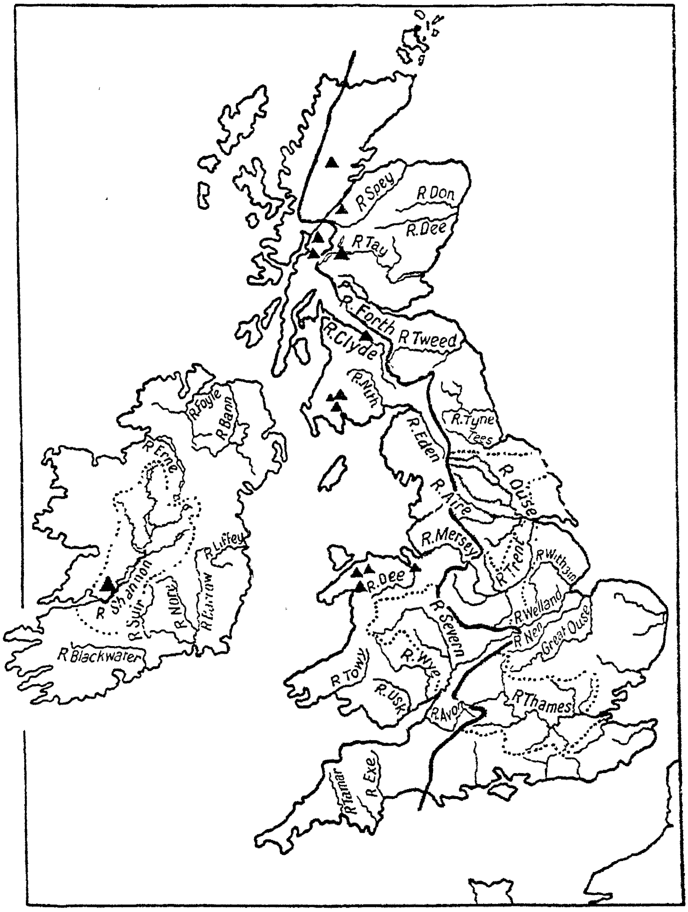


FIG. 64.—The chief rivers of the British Isles.

The heavy line shows the main water parting; five of the larger basins are separately indicated. The black triangles are points where water power has been developed.

country must have obliterated there the free surface drainage. As the ice spread southwards so natural drainage channels were in many cases blocked and pent-up waters were compelled to find their way into new channels; in many cases they have never gone back to the old ones. The tongues from the ice sheets were responsible

for the deepening of many of our valleys, especially in the Highland Zone. Thus many of the well-known lochs of Scotland are of glacial origin, so also are the famous lakes of our Lake District; whilst amongst the higher parts of the mountains of Wales the circular "cwm" or corrie lakes do much to add to the beauty of the scenery of that country. With the gradual departure of the ice sheet many pre-existing valleys were thickly covered, perhaps even obliterated, with glacial debris, effectively blocking old lines of drainage. In the lower parts of the country, especially where the glacial debris was clayey or impervious in character, there resulted the ill-defined drainage which to this day is characteristic, for example, of so much of the Central Plain of Ireland. Amongst the other marshy lands left behind were the Vale of York and the Fenlands of England.[1] The third stage in the evolution of the river system of the British Isles has been marked by the small, but cumulatively important, efforts of man to control drainage and more especially to drain some of the lower lying areas. How successful this has been can be judged by the complete conversion of the Fenland into what it is to-day—one of the best agricultural regions in the British Isles, and the almost equally complete drainage of the Vale of York. To a less extent man has controlled the drainage of the country for his own ends, for purposes of water supply.

The Utilisation of the Water Resources of the British Isles

It is remarkable, indeed well-nigh incredible, that there has been up to date no comprehensive study of the fresh water resources of Britain. Whilst almost from time immemorial such rivers as the Nile have been studied day in and day out, and their exact flow measured by gauges, no such records exist for British rivers. The seasonal rise and fall of rivers is a study of the utmost importance in many countries of the world. Their characteristic régime, as this rise and fall is called, may be a factor of national significance; but we do not know the régime of even the larger British rivers. Probably the Thames, because of its importance for the water supply of London, is the only river whose resources are comparatively accurately known. What is the reason for this neglect of the study of an important national resource? It is in the main a reflection of the climatic conditions of these islands. Broadly speaking, in the past we have always had a superabundance of water for our requirements. The trouble has usually been too much water, and the difficulty of getting rid of the surplus. Thus the necessity of organising a survey of our national water resources has not, until

[1] For an account of some outstanding examples of glacial interference with drainage, see L. J. Wills, *The Physiographic Evolution of Britain,* pp. 211–228. Many of the papers listed on p. 56 deal with the evolution of drainage.

recent years, become apparent.[1] In the utilisation of our water resources it may be said that there are at least five frequently conflicting interests which regard the water resources of the islands from five different points of view:

(*a*) Land drainage.
(*b*) Water supply.
(*c*) Transport, *i.e.* navigation.
(*d*) Water power.
(*e*) Fisheries.

(*a*) **Land Drainage.**—In 1927 a Royal Commission, under the chairmanship of Lord Bledisloe, was appointed to inquire into the whole question of land drainage in England and Wales. In the evidence presented to that Royal Commission it was stated that there were $1\frac{3}{4}$ million acres of land in England and Wales alone in urgent need of drainage, and that 4,362,000 acres, about one-seventh of the land in agricultural use, depended absolutely on artificial drainage. There are still many parts of the British

[*Photo: L. D. Stamp.*

FIG. 65.—Floods from the River Don, near Doncaster (Spring of 1932), illustrating the acute need for further drainage in parts of Britain.

Isles which are subject to disastrous floods. To quote one example, in the valley of the lower Don, no less than 79 per cent. of the total area of 212,500 acres of the Doncaster area is below the 25-foot contour, and in urgent need of provision of adequate drainage.

[1] But the position is now rapidly changing owing to conflicting interests, and in 1932, at its York Meeting, the British Association set up an Inland Water Survey Committee to discuss ways and means whereby such a survey could be undertaken. This was followed by a Government Committee.

The position is that the natural river channels are only sufficient to take off the surface water in times of normal flow and prove quite inadequate in times of excessive rainfall, which therefore results in widespread flooding. In the past, land drainage engineers have had to take a purely arbitrary figure in calculating the run-off from the catchment basin with which their works would have to deal. It has been considered as reasonable to take as a normal maximum run-off one-hundredth part of the average annual rainfall over the catchment area for 24 hours. Thus, if the average rainfall of the catchment area is 25 inches per year, it has been considered necessary to construct the drainage works to take off the equivalent of 0·25 inch per 24 hours. This is admittedly insufficient to deal with exceptional floods, but the cost of providing for a flood which might occur once in 50 years is entirely prohibitive. Taking the case of the River Thames, of which some accurate figures do exist, the largest flood recorded was due to very exceptional rainfall in the year 1894 when the discharge reached 20,236,000,000 gallons per day on November 18. This is equivalent to 15·24 cusecs[1] per thousand acres over the whole catchment area, or equivalent to 0·36 inch of rain on the whole area of the Thames Basin. In the 26 days from October 23 to November 17 of that year over 8 inches of rain fell in the Thames Valley, or an average of 0·31 per day. The River Thames when it is running bank high is able to discharge 4,500 million gallons per day—a quantity which has been exceeded on about 12 days per year since 1883. Improvement works now in hand between Weybridge and Teddington will enable the river to discharge roughly double this quantity. It is not considered practical to provide for floods of greater magnitude which are of very rare occurrence. Thus it must be accepted that some 150,000 acres in the catchment area of the River Thames are subject to inundation in times of high floods and that they must remain so subject. By way of contrast, the minimum flow recorded for the Thames is 155,000,000 gallons per day in September, 1906. Broadly speaking, it is only in the smaller catchment basins that a single day's heavy rainfall will be reflected in a serious flood. Thus in east Norfolk, one of the most disastrous floods on record of the river Wensum (on August 6, 1912) was due to a fall of rain of 7·3 inches in one day, though the river provided itself automatically with water storage by overflowing the lowland on each side to the extent probably of as many as 10,000 acres. Summarising the question of land drainage, it may be said that:

(*a*) Much land in the British Isles urgently requires drainage to render it of greater agricultural value.

(*b*) The channels of main rivers in particular require improvement so that they are able to take off up to about twice the

[1] Cubic feet per second.

amount of water which they can take off at present. Payment for such work that is considered necessary should be obtained by rates on the owners of land situated below the flood level, taken normally as 8 feet above the mean level of the river.

(c) For purposes of dealing with the problem, and as a result of the Royal Commission mentioned above, the Land Drainage Act, 1930, provides for the division of England and Wales into 47 catchment areas for which Catchment Boards have been constituted. The boundaries of these catchment areas are now regularly shown on all new issues of the 6-inch Ordnance Survey maps.

(b) **Water Supply.**—If it is the object of the land drainage engineer to drain the land effectively and conduct the water as easily and as quickly as possible to the sea, the object of the water supply engineer is quite different. His purpose is to conserve a supply of pure, good quality water so that it may be available in quantity to the populace at large at all seasons of the year, independent of periods of drought. The domestic and industrial water supply is derived in the main from three sources :

(a) Shallow or superficial wells which go down as far as the permanent water table, and from which the water can be pumped up.

(b) The deep wells which tap deep-seated supplies, including artesian water.

(c) River supplies, or gathering grounds whose water has been conserved in natural lakes or artificial reservoirs.

In country districts the normal water supply is still obtained to a large extent from wells, supplemented in many cases by supplies from natural springs.[1] In the same areas the method of disposal of sewage is by cesspools or pits in the ground, and the relative siting of well and cesspool is a matter of the first importance. There is in the underground water table a definite movement of water, usually, but by no means always, down hill by relationship to the surface of the ground, and obviously the cesspool should be on the down flow side from the well; but with the utmost precaution pollution is likely to occur and with an increase in population the provision of a permanent water supply is a first essential. The drilling of deep wells is perhaps most frequently undertaken by firms and individuals who wish to have an assured supply apart from that provided by water supply companies.[2] Where there are numerous wells drawing

[1] In 1914 out of 12,869 parishes in rural districts in England and Wales, only 4,874 had a piped water supply even to some of the houses.

[2] In England and Wales every landowner has the right to use, but not to sell, water naturally flowing through, past, or under his land provided there is no interference with the rights of neighbouring landowners.

upon a deep-seated underground supply, particularly an artesian supply, as under London, it has become quite clear that the water is by no means inexhaustible, and the level of the artesian water under London has been lowered appreciably within the last 50 years. The problem of water supply is obviously most acute in the large conurbations. In many cases, as for example, London,

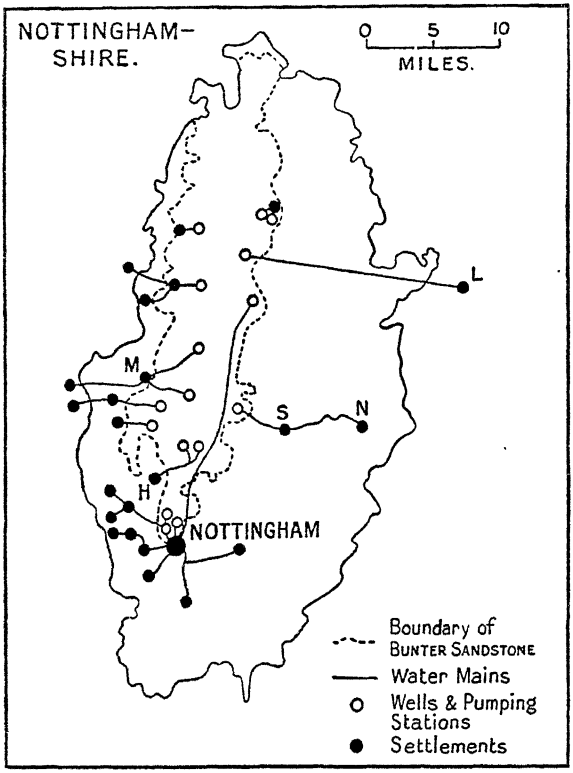


FIG. 66.—Sketch map illustrating the importance of certain geological horizons (in this case the Bunter Sandstone) as water-bearing beds. (*After Prof. H. H. Swinnerton.*) The most valuable water-bearing formation in south-eastern England is the chalk, but many permeable or partly permeable beds such as sandstones and fissured limestones are locally important. Surface gravels are liable to pollution.

provided the quantity of water removed does not affect the use for transport, navigation, and other interests of the riverine owners, it is possible to draw a water supply from all the larger rivers.[1] The bulk of London's water supply is taken from the River Thames above Teddington, supplemented by a considerable supply from the

[1] 139 water companies use river supplies. Some of the most important rivers used include the Thames and its tributaries Lee and Kennet, Severn and tributaries Avon, Chelt, Wye and Elan, Derwent, Tees and tributary Balder.

Lea Valley or the New River Waterworks. In some of the other conurbations the problem is not quite so simple. Obviously the most suitable collecting grounds for water supply for a large city are the open moorlands or hilly areas which have a heavy rainfall, but where there is not a large animal or human population living on the hills which would naturally pollute the supply of water. Thus it is not too much to say that there has been a scramble amongst the more powerful city corporations to secure rights for this purpose over the more thinly inhabited parts of Wales, the Pennines, the Lake District and elsewhere. There is great competition

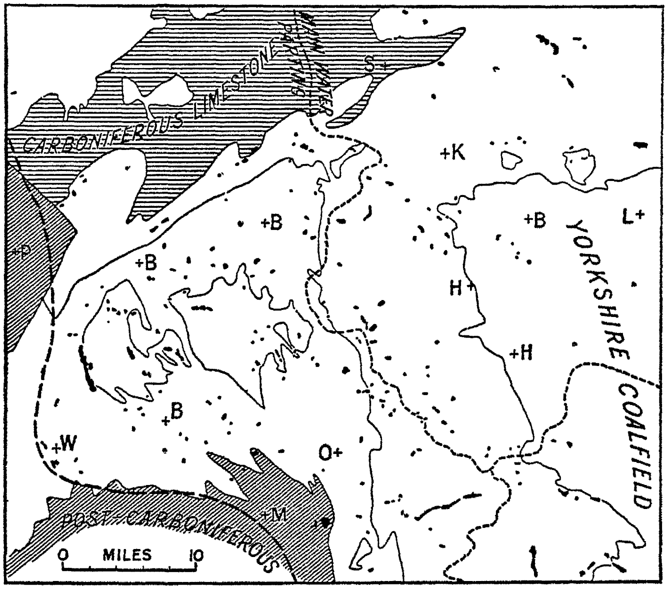


FIG. 67.—The Pennines as "gathering grounds" for water supply.

All the black areas are reservoirs and no less than 220 are shown on this map. The blank areas are Millstone Grit and Coal Measures, on which nearly all the reservoirs are situated. The broken line in the west is the western limit of "soft" water (see p. 483).

amongst the towns on the two flanks of the Pennines to secure the rights for areas of drainage and water supply from the Pennines themselves.

Water from the Pennines supplies the needs of about 18,000,000 people and reservoirs, as shown in Fig. 67, are closely spaced. But the supplies were obviously becoming inadequate. The Corporation of Liverpool cut the Gordian knot by damming up the previously rather uninteresting valley of Vyrnwy in Wales; thereby creating Lake Vyrnwy, with a surface 825 feet above sea level and forming the largest single inland sheet of water in Wales—5 miles long and

[Photo L. D. Stamp.

FIG. 68.—Lake Vyrnwy (Corporation of Liverpool Waterworks), Wales.
Showing the additional work carried out by the Corporation in afforestation.

on an average nearly a mile wide. It was constructed between the years 1880 and 1890, and has a surface area of 1,121 acres, its

FIG. 69.—Statutory Catchment Areas under the Land Drainage Act of 1930.

There are about 1,000 statutory water authorities in England and Wales (borough, urban and rural councils, etc.) and about 1,000 private water supply companies. Part of the object of establishing the statutory catchment areas is to secure better domestic water supply.

Much information on this subject will be found summarised in R. C. G. Walters' *The Nation's Water Supply*, especially pp. 165–213.

storage capacity being 12,131 million gallons, and the catchment area nearly 36 square miles. The Vyrnwy, it should be added, is the chief Welsh tributary of the river Severn, and was formerly a small stream meandering across a marshy flat. The suitability

of the site depended to a considerable extent on the hard old rocks of the neighbourhood forming a suitable foundation for the masonry of the reservoir dam. The Corporation of Birmingham followed suit by constructing a series of four reservoirs in the beautiful valley of the Elan about four miles west of Rhayader. These were completed in the years 1893–1904 at a cost of no less than £5,750,000. They cover 900 acres and yield a daily supply of 75 million gallons from a gathering ground of about 70 square miles, the storage capacity exceeding 10,000 million gallons. From these reservoirs there are, of course, gigantic aqueducts, for the most part near the surface, though hidden, running from the heart of Wales in each case to Birmingham on the one hand and to Liverpool on the other. Manchester has utilised the natural lake Thirlmere in the Lake District under the shadow of Helvellyn. A fear that the supply from Thirlmere would be insufficient for the growing city led to the development of another scheme in the Lake District for using Haweswater. After about £1,000,000 had been spent, the scheme was postponed in 1932 as not at the moment necessary. This action gave rise to considerable discussion because it came just at a time when Hull had decided on a new scheme at a cost of £1,500,000 to obtain an independent water supply. In a letter to *The Times* of November 18, 1932, it was suggested that the time was ripe for a water grid all over the country corresponding in character to the electricity grid which at present is being developed and likely to prove so successful. It was suggested, for example, that a trunk main across the country using Haweswater for a supply would meet the future needs both of Manchester and of Hull, and that from this main there might be a southern extension to the dry areas of Lincolnshire, so removing the risk of drought from a country region still dependent upon wells. A continuation of such a main could pass through Cambridgeshire, Suffolk and Essex, eventually connecting up with the London supply, and then continuing west and south to other areas of the country. Clearly such a uniform grid for our main water supplies will be necessary in the future.

For certain industrial purposes, the quality or type of water is of importance. Thus it is well known that the supplies of soft water have in large measure been responsible for the location of the textile towns of Lancashire and Yorkshire, since soft water is so essential for washing and dyeing the raw materials and fabrics (see Chapters XX and XXI). But with the modern development of the water softener it would not be difficult for firms concerned to install the necessary machinery, just as the railways already do for softening their water. Similarly, although the local well water from the gypseous Keuper Marls with its considerable permanent hardness was largely responsible for the development of the brewing industry at Burton, " burtonisation "

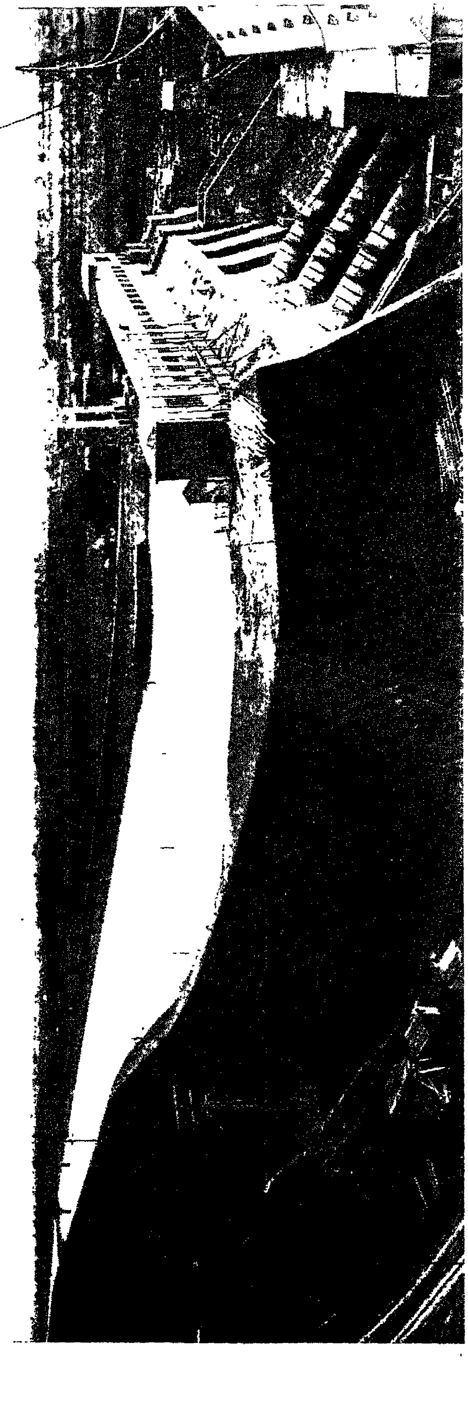
or artificial hardening of water for brewing purposes is now commonplace.[1]

(*c*) **Transport.**—The utilisation of British inland waterways for transport and navigation purposes and their linking by canals is considered elsewhere (see Chapter XXVII). It may be noted here, however, that the land drainage engineer in embanking the rivers to prevent excessive flooding also benefits the users of waterways in that firmness of banks is secured, and a deeper and narrower channel tends to be formed. Many of our rivers have been changed out of all recognition in this way. Thus it is difficult to imagine at the present time a ford across the Thames, as undoubtedly there was in early times, in the neighbourhood of London Bridge. The river has been so enclosed by embankments on either side that the current has become swift, and the actual watercourse deep. It may be appropriate to mention at this point, too, the enormous importance of the mouths of British rivers. The river mouths are often more important than the rest of the river because of the situation thereon of many of our great ports. Here the climate of these islands, with its well-distributed rainfall, is responsible for the steady flow of most of our rivers throughout the year. This, combined with the marked tidal scour consequent upon the large tidal range characteristic of the Continental Shelf round the British Isles, has been in a large measure responsible for the development of so many of our ports.

(*d*) **Power.**—The hydro-electric power resources of the British Isles are not large. In the days before the extensive utilisation of coal, the small swift streams running down from the Pennines were extensively used for driving machinery. The sites of the early forges and grinding works, for example in the Sheffield district, and of cotton mills in South Lancashire, were undoubtedly determined by the water-power available from the streams. In many parts of the country water-power was also used in small flour-mills, but most of these primitive establishments have fallen definitely into disuse. A few years ago a Water Power Resources Committee of the Board of Trade was appointed to inquire into the resources of the British Isles. They calculated that if all the schemes put before them were developed, 250,000 kw. continuous could be generated. Of this, 210,000 kw. could be developed at an economic rate—equivalent to 1,840 million Board of Trade units per year, and representing a saving roughly of 3,000,000 tons of coal per annum.[2] This was equal to 40 per cent. of the total units generated

[1] The third edition of the *British Waterworks Year Book and Directory*, 1930–1931, gives particulars of 871 water undertakings. In addition to 137 using river supplies, 167 depend on gathering grounds and reservoirs; springs supply some water to 520, whilst 495 depend wholly or partly on underground supplies.

[2] These figures are for Great Britain. The detailed figures are Scotland, 195,000 kw.; Wales, 36,000 kw.; England, 20,500 kw. No calculations were made of *total* power resources, but for Ireland this was estimated at 280,000 kw.



[Photo Topical Press.

FIG. 70.—The Shannon Power Scheme.

View of the Power House at Ardnacrusha in 1929, shortly before completion of the first half of the scheme.

in 1917–18. In general the mountainous areas are too small to get a sufficient head of water. Notwithstanding the disadvantages, some interesting schemes have been carried through, some of which are mentioned below. It is not known what is the horse-power generated by hydro-electric power established in the British Isles, because it is the policy of the private companies who have directed these works to keep this information to themselves.

The Shannon Power Scheme.[1]—By far the largest and most ambitious scheme in the British Isles is that for harnessing the River Shannon. Ireland is practically devoid of coal, and so is under the necessity of importing her fuel, hence the great incentive to the construction of these power works which make Southern Ireland—Eire—virtually independent of imports of coal for many industrial purposes. The Government of the Irish Free State did not act on the proposals of the Board of Trade Committee just mentioned, but appointed a Commission of its own which entered ultimately into an agreement with a German firm—Messrs. Siemens Schuckertwerke—in February, 1924, the proposals being submitted to Dàil Eireann in 1925, and the Shannon Electricity Act was passed in June of the same year. The River Shannon has a long meandering course over the central drift-covered plain, passing through three large lakes, Loughs Allen, Ree, and Derg, and in 125 miles of its length has a fall of only 55 feet, or less than 6 inches per mile. The flow is sluggish, the flooding of adjacent areas common, but from Lough Derg to the sea a remarkable change takes place. The surface of Lough Derg was about 100 feet above mean sea level at Limerick and from Killaloe at the southern end of the lake to Limerick is only a distance of 15 miles. The river made its way through a series of rapids, cutting almost a gorge through the hard rocks which there cross its bed. The local details of the scheme as carried out are shown in Fig. 71. By means of an embankment below Killaloe the surface of the lake was raised some 10 feet so that it is now 110 feet above O.D. Fortunately, Killaloe is built on

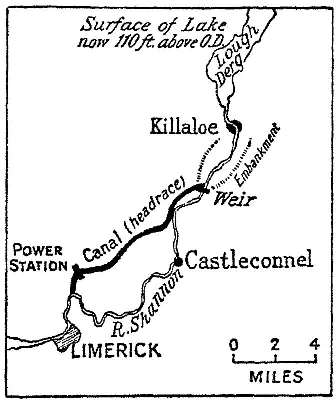


FIG. 71.—Details of the Shannon scheme.

[1] C. S. White: "The Shannon Hydro-Electric Power Development," *R. Eng. Jour.*, XLIII, 1929, 94–106. A. Fletcher: "The Shannon Scheme and its Economic Consequences," *Jour. R. Soc. Arts*, LXXVIII, 1929, 478–490. Brysson Cunningham: "The Shannon Hydro-Electric Power Development Scheme," *Nature*, CXXIV, 1929, 763–766.

rather higher banks of the river, and the little town has not suffered. At the southern end of the embankment a large weir was constructed, and then the bulk of the water taken through a canal or headrace to the power station just above Limerick where the full fall of nearly 100 feet could be utilised, the spare water being allowed to find its way through into the Shannon. The power house is at Ardnacrusha, from whence the race discharges the spare water into

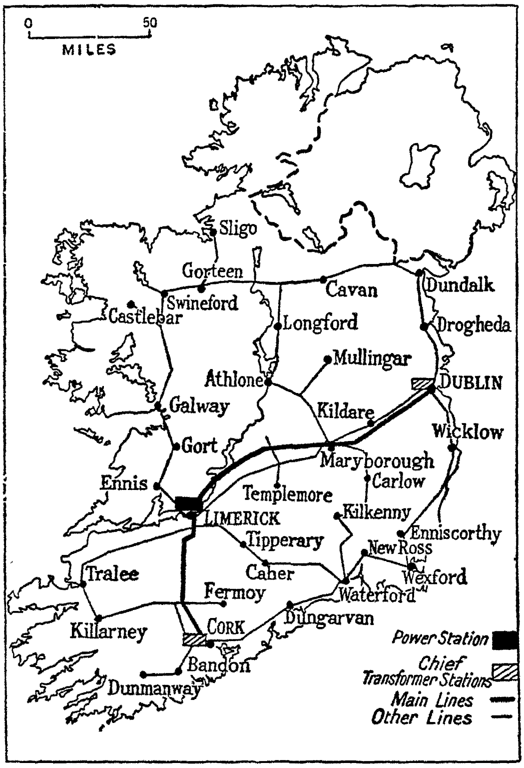


FIG. 72.—The Irish Electricity Grid, distributing power from the Shannon works.

the Shannon near Limerick. The water in the tailrace is influenced by the tide, the net fall varying from 86 to 115 feet. The scheme has been developed in two parts. The first part (which was completed in October, 1929) involved the three steel tubes shown in the photograph and three turbine generators. Above Killaloe, throughout the Central Plain, the river is navigable and a barge canal has been constructed at the side of the power works so as to permit continuous navigation from Limerick. Further a small canal with a series of steps to be utilised by salmon has been made, since salmon fishing in the Shannon is of very considerable value. The power generated

at the power works is to be conducted by overhead lines to practically all parts of Eire and sufficient electricity will be generated not only to light the whole of Eire, and to run its existing industries, but also to make possible the development of new industries. The second part of the scheme will involve three more turbines and will double the output.

The River Bann Scheme.—A somewhat similar scheme was considered for the utilisation of the fall of the lower Bann, combining with the scheme improvement of the drainage in the area around Lough Neagh. Drainage works are at present being carried out, but independent of any development of hydro-electricity.

The North Wales Schemes.—There are three hydro-electric power schemes in North Wales, one on the slopes of Snowdon utilising the fall from a corrie lake, one at Maenturog and one at Dolgarrog. It is rather a curious sight to see, especially at Maenturog, the power being carried by overhead cables over the vast stretches of the moorlands of Wales, linking up these supplies with the main grid system (see Fig. 225).

Chester.—A very old scheme utilised the falls of the Dee at Chester and the present works supplement to a small extent the generation of electric power from coal.

River Clyde.—The falls of the Clyde supply two power stations, one using the Stonebyres Falls and the other the Bonnington and Corra Linn Falls.

Galloway.—The Galloway Power Company uses the waters of the rivers Dee and Doon, with the natural reservoir of Loch Doon, to supply five power stations, erected between 1929 and 1936. The largest of these is at Tongland, near Kirkcudbright, and the others are at Glenlee, Earlstoun, Carsfad and Kendoon, all in the New Galloway—Loch Doon area. This extensive system, developing over 100,000 kw., supplies the greater part of south-west Scotland.

The Highlands.—The Scottish Highlands, with their heavy rainfall and numerous natural loch-reservoirs, form the most extensive area in Britain in which hydro-electric power is possible, and numerous developments, either for the smelting of aluminium (cf. p. 429) or for domestic and other industrial purposes, have taken place since 1896, and are still in progress. The earliest station was erected at *Foyers*, on the eastern side of Loch Ness, in 1896, for the smelting of aluminium. The years 1907–9 witnessed the erection of a 25,000 kw. power station at *Kinlochleven*, at the head of a marine loch, to which sea-going steamers have access. The water comes from the moor of Rannoch to the east. Quite a considerable town has grown up around the aluminium works, now belonging to Imperial Chemical Industries, which have been established. The Lochaber Power Company, established in 1921, has achieved fame by driving a 15-mile tunnel to carry water from

Loch Treig through the heart of Ben Nevis to near *Fort William*, there to generate electricity for the aluminium factory built just north of the town in 1929. Lochs Treig and Laggan are dammed to increase their storage capacity, and it is intended also to divert the headwaters of the river Spey into Loch Laggan. The *Grampian* system, begun in 1928, comprises two power stations utilising the abundant water-supply of the great Rannoch upland. The Rannoch installation uses water from Loch Ericht, and sends an overland power line to Abernethy, and so to Stonehaven, Montrose and Ballater; the Tummel station uses water from Loch Rannoch. Much further north, in *Ross-shire*, the Scottish Power Company has a station at Loch Luichart, using water from the river Conon, and supplying power to Nairn, Dingwall and Dornoch.

Other developments in the Highlands are likely to take place in Glengarry, west of Fort William.

The Severn Barrage Scheme must also be mentioned here, though its aim is to harness the tide of the Severn estuary. The cost is estimated (1933) at £29,000,000, and the power to be generated at 2,200,000,000 units per annum (cf. p. 535).

(*e*) **Fisheries.**—Most of the British rivers were once celebrated for their trout, their salmon, and for other fish. Many have become so polluted that the fish have disappeared, but in others fishing is very carefully preserved and the sporting rights guarded by angling societies and private owners. It is difficult to calculate the value of fresh-water fish in British rivers. Possibly the value of salmon and other fish obtained in Ireland approaches £1,000,000 annually; the value from Scottish rivers must also be high.

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CHAPTER VI

THE SOILS OF BRITAIN[1]

PEDOLOGY, or the study of soils, is a study which, as a modern science, is still in its infancy. The soil is, of course, the surface layer of earth on which the land plants grow. The mineral matter is in the main derived from the underlying rocks by weathering, and it might be thought therefore that this part of the soil would vary directly according to the character of the underlying rocks, and therefore that a geological map would form the necessary basis for the construction of a soil map. Of recent years, however, it has been more and more recognised that climate plays a leading part in determining the character of the surface soil. So much is this the case that in many tropical countries it is almost impossible to distinguish laterite, or lateritic soil, which has been formed from underlying granite, and lateritic soil which has been formed from underlying shales. Or, again, over the vast plains of Russia it is found possible to map great soil zones which correspond with the climatic zones. It is found that percolating rain-water (partially or completely saturated by CO_2) dissolves certain constituents, and may remove them, whereas in other cases water with salts in solution may rise to the surface through capillary action, and when the water evaporates the salts will be left behind in the surface layers.

Thus moisture is one great factor of climate which is concerned in differentiating soils. In studying soils it is necessary to consider not only the surface layers but also the lower horizons. Indeed, it is usually possible to distinguish three horizons, frequently called the A, B, and C horizons, the three together constituting what is technically called the profile of the soil. The A horizon, or the upper layer, is that from which certain substances have been dissolved or washed out by rain-water and taken downwards to the lower layer or B horizon. There the dissolved salts may be precipitated more or less unchanged or they may interact with other substances in that layer. Lower down is the unaltered or slightly altered parent material of the C horizon which in general does resemble the underlying rocks or may actually be the solid rock.

Taking the world as a whole, its soils may be divided into four very broad groups :

(1) *Podzols* or podzolised soils. These are formed under

[1] The authors are greatly indebted to Professor E. J. Salisbury, F.R.S., for valued criticism and comments on this chapter, and to Dr. W. G. Ogg, Director of the Macaulay Soil Research Institute, Aberdeen, for further detailed notes.

conditions of good drainage where rainfall is greater than evaporation and are characteristic of the cooler parts of temperate lands. The surface layers are "leached" by removal downwards of soluble constituents and in addition the colloidal clay complex is broken down under acid conditions and the sesquioxides removed. The result is that below a dark surface layer (the colour due to organic matter) there is a grey A_2 horizon consisting largely of pure silica (sand). This is the most distinctive feature of a podzol. The B horizon is enriched by deposition from above.

(2) *Chernozems* or black earths are formed under conditions of rainfall nearly equal to evaporation and such cold winter conditions that the decomposition of organic matter is brought to a standstill. Breakdown of the clay complex does not take place.

(3) *Solonchak* or saline salts are formed under conditions of rainfall less than evaporation and where there is a fairly high ground water table rich in salts.

(4) *Laterites* or lateritised soils are formed under conditions of high rainfall and high evaporation, mainly in the tropics.

There are other groups: the position of the "brown earths" or "brown forest soils" is difficult to define. The presence of a high water table interferes with the normal development of a soil profile and there is a whole group of "ground water soils."

It must be remembered that the whole of the British Isles lies in one climatic belt and that not one of extreme conditions. It is not, therefore, to be expected that the soils of the British Isles would show the great differentiation due to climate which is found in such large tracts as Russia. The soils of the British Isles thus belong to two broad groups—the podzols and the brown forest soils—of continental authors, with the exception of limited development of special types. In the British Isles the soils actually vary enormously according to parent material or to human influence, despite the uniformity of climate, and are thus sometimes called "aclimatic." Thus whilst alkalinity, due to dry conditions, may be almost entirely absent it is still, however, possible to distinguish the important effects of excessive moisture or of moderate moisture. Thus the mineral particles which constitute the basis or foundation of a soil are derived from the underlying parent rocks, but the mineral salts are not of necessity present in the same proportions as in those underlying rocks. In any case the mineral particles do not constitute the whole of the soil. Wherever vegetation has existed the plants themselves have built up complex organic substances from the carbon dioxide of the air, combined with the mineral salts such as nitrates obtained from the soil. They use for this purpose the energy of sunlight in the presence of that remarkable green colouring substance chlorophyll. When the plants die their dead remains fall back and there is introduced into the soil a new group of constituents—organic compounds containing constituents which may have been absent from the rock from which the soil is in the main derived. In some cases the organic substances become quite definitely the dominant constituents in the soil in determining its character and its suitability for different types of utilisation.

Broadly speaking, it may be said that four factors have determined the distribution of the different types of soil in the British Isles.

(1) *Parent material, including solid rocks and drift.*—We have

seen that five-sixths or more of the British Isles were at one time or another covered by great ice sheets, that the ice sheets removed soil from over huge areas, mixed fragments of rock of very varying character, and eventually distributed over the surface of the land a mantle of deposits of very varying thickness which are collectively known as drift. Quite a large proportion of these drift deposits were further re-sorted by water action—in some cases by waters derived from the melting of the ice, in other cases by more recent streams. It may even be that some of the finer particles were partly re-sorted by wind or by wind and rain. What is of fundamental importance is that these surface deposits are very widespread. The geologist who is concerned mainly with the structure of the earth's crust tends rather to regard these mixed drift deposits as of little importance, very often as a distinct nuisance in that they obscure the character of the underlying solid rocks. They are very varied, difficult to classify, and not perhaps very interesting to study in detail in themselves. Thus the geologist who deals with the solid rocks underlying the drift deposits often ignores the drift, and it is significant that there is not in existence at the present day a complete map of England and Wales which shows the distribution of drift deposits.[1] In some of the eastern counties, particularly in East Anglia where they assume a huge importance, they have been mapped, and the Geological Survey publishes quarter-inch maps of this part of England in two editions, one showing the solid rocks with the drift removed, and the other showing the drift deposits as they actually are. The drift deposits assume a still greater importance in Ireland, and many years ago a general geological map of Ireland was brought out showing the

FIG. 73.—The drift-covered areas of England and Wales.

The stippled areas are almost wholly drift covered: the black areas would be submerged if the drifts and later deposits were removed. (*After L. J. Wills and G. W. Lamplugh.*)

[1] This is not, of course, true of the modern maps prepared by the Geological Survey and published on the scale of one inch to one mile. Most are published in two editions, Solid and Drift, and are magnificent examples of detailed work.

distribution of drift deposits.[1] Because of the absence of a general drift map of Great Britain the geographer is too often thrown back on the solid geological map, and it is a fundamental, but a very common, error to suppose that this is a satisfactory basis for studying the soils of England, Wales and Scotland. In the southern counties, which were little affected by glaciation, this may sometimes be the case, but north of the Thames it certainly is not.

Where drift deposits are absent, or where the drift is very thin,

Fig. 74.—The principal boulder clays of eastern England. (*After F. W. Harmer, "Geology in the Field."*)

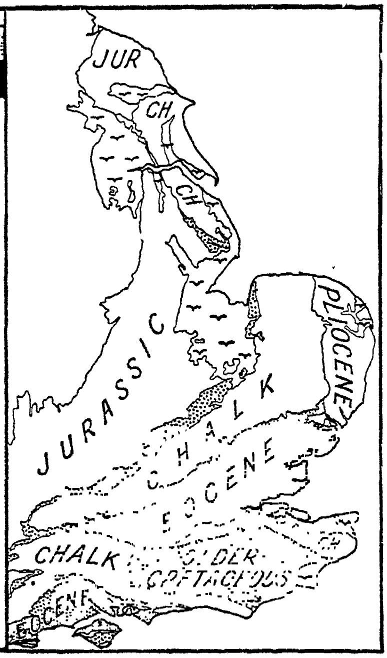

Fig. 75.—The solid geology of eastern England.

then the character of the underlying rocks is of the greatest importance in determining the type of soil. Thus the stiff Weald Clays give rise to the stiff clay soils of the Wealden area, the sands of the Lower Greensand to sandy soils, and so on ; but it is a mistake to pay too much slavish attention to the geological map, for the poorer siliceous soils of the Highland belt, as for example of Wales, vary but little in character whether they are derived from Cambrian, Ordovician, or Silurian rocks, although there may be considerable variation *within* any one of these groups or in rocks of the *same* age in different parts of the country.

[1] *Surface Geology of Ireland* (10 miles=1 inch), by Sir A. Geikie. (Bartholomew.)

(2) *Climate*, including soil climate. On the whole, of course, there is a general increase in the amount of rainfall as one goes from east to west in the British Isles. On the whole there is a general tendency for peat formation to increase as one goes in the same direction. An important point, not always realised, is that one must regard the rainfall of a considerable part of the British Isles as excessive; even if drainage operations were undertaken it is likely that the climatic conditions are such that the soils would not even then be suitable for arable farming. This applies, for example, to many parts of the Highlands of Scotland.

(3) *Vegetation*, including former vegetation.—The former vegetation cover of numerous areas plays an important part in the character of the soil which is found at the present day.

(4) *Topography*.—The degree and direction of the slope of the land is important in its relation to drainage.

We may now attempt a classification of British soils, especially in relationship to their effect on agriculture and the natural vegetation cover. Two broad groups are to be distinguished:

(1) Mineral soils.—Those which owe their principal characteristics to the size and character of the mineral particles present.

(2) Organic soils.—Those whose dominant characteristics are determined by the character and relative quantities of organic compounds present.

(1) **Mineral Soils.**—Apart from the presence or absence of calcareous material, the properties of mineral soils are determined largely by the proportion of particles of different sizes. For purposes of study particles have been grouped arbitrarily under the following types:

Diameter above 2 mm.—stones.
Diameter between 0·2 and 2 mm.—coarse sand.
Diameter between 0·02 and 0·2 mm.—fine sand.
Diameter between 0·002 and 0·02 mm.—silt.
Diameter below 0·002 mm.—clay.

Sandy soils usually contain more than 60 per cent. of coarse and fine sand and less than 10 per cent. of clay. Owing to the large size of the particles they present but a small surface for retention of water; they are easily permeable by air and also by water, and hence plant roots can not only penetrate such soils easily but can also " breathe " easily. Water may drain rapidly away from the roots and so the plant roots may suffer from drought. On the other hand these soils are easily cultivated, but not infrequently are deficient in plant foods because the freely moving water dissolves the plant foods and removes them.

Loamy soils contain a smaller percentage of coarse and fine sand, but a larger proportion of silt and clay. They are less easily permeable, but sufficiently so to allow the ample aeration of roots

soil with a good proportion of humus may be described as the most fertile of all soils, and where the Fenlands of England have been drained are some of the most fertile agricultural lands anywhere to be found, and it will be noticed that the characteristic colour of the soil is almost black, due to the large proportion of humus present.[1] Where, however, the aeration of the soil is deficient, usually due to the excess amount of moisture, then there tends to be an accumulation, not of humus but of humic acid.

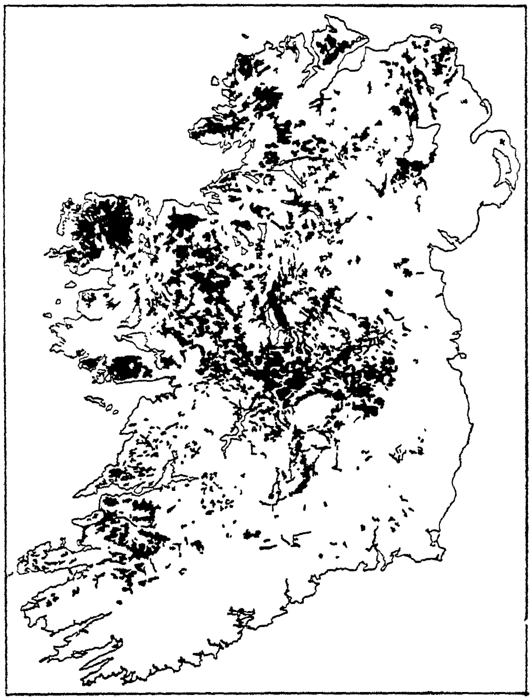

FIG. 76.—The peat-bogs of Ireland.

All areas in solid black are covered with peat and bogland. The predominance in the Central Plain and in the West should be noted.

Peaty and moorland soils.—In peaty and moorland soils the great defects are acidity due to the excess of humic acid and poor aeration, in turn due to conditions of excessive moisture. In some cases by draining, or by the admixture of a proportion of calcareous material. a peaty soil may be converted into a very rich humic soil, but there are other areas where the acidity is so great that the expense of treatment is prohibitive even by these simple means. This, of course, is particularly the case in moorland areas where the drainage is bad.

[1] Though humus is dark in colour some of its constituents are not.

Perhaps a better classification of organic soils would be :

(*a*) Mild humic soil or mull, such as is normally found on the floors of deciduous woods, in meadows, gardens, etc., and has a neutral reaction or is only slightly acid or alkaline, being well aerated by earthworms, etc. (Brown Earth.)

(*b*) Fen or mild peat, formed where there is an excess of water but a deficiency of oxygen, as on the margins of lakes ; but the water gives an alkaline reaction because of the presence of lime or other bases in quantity. When drained this is the rich humic or the black soil of the Fenland area.

(*c*) Raw or acid humus is formed on soils deficient in lime and is characteristic of podzolised soils under coniferous woodland and on dry heaths. Oxidation is not necessarily deficient, but the soil must be so acid that the humus is unsaturated and earth-worms are absent.

(*d*) Acid peat. Under conditions of excessive moisture and excessive deficiency of oxygen acid peat accumulates and a pure peat soil is produced. If the conditions are maintained this acid peat soil may reach a great depth giving the characteristic moor soil with moorland vegetation.[1]

Under mineral soils above, mention ought to have been made of those soils which have special characteristics due to the presence of quantities of salts—for example, the salt marshes—whilst a separate category must be preserved for rocky soils or hard rock, not covered by loose earth or by soil in the generally accepted sense.

The Distribution of Soil Types in the British Isles

1. *Mineral Soils derived from Drift deposits.*—The deposits left behind after the retreat of the ice sheets of the great Ice Age vary enormously in character. The following broad types of soil derived from these and other superficial deposits may be distinguished:

(*a*) *Boulder Clay.*—This is usually a stiff clay with numerous boulders of rock of very varied size transported from a distance. As a rule the soils derived from Boulder Clay are stiff heavy clay soils and hence little cultivated but rather left as grassland. In the wetter parts of Scotland and Ireland particularly they tend to be waterlogged and to give rise to acid humus soils or acid peaty soils. The same happens with compact soils even if not true clays.

(*b*) *Chalky Boulder Clay.*—A special place must be made for the boulder clay, common in parts of eastern England, where there is a considerable admixture of chalk. This ameliorates the normal character of the clay soil derived, and the chalky boulder clay is frequently very fertile (see pp. 236–7).

(*c*) *Loamy Glacial Drifts*, such as those derived from the Old Red Sandstone in Scotland and in parts of England. Because the

[1] This is the classification used by Tansley in *Types of British Vegetation*, p. 35.

soils are well mixed they may be very fertile and hence the land is largely cultivated. This is the case in the Lothians of Scotland around Edinburgh.

(*d*) *Glacial Sands.*—Particularly conspicuous in Ireland are the dry grass covered gravel ridges, known as " eskers," and the sandy, loamy or stony, sometimes clayey, knolls of glacial drift called drumlins. Where the sands are coarse and the water drains away

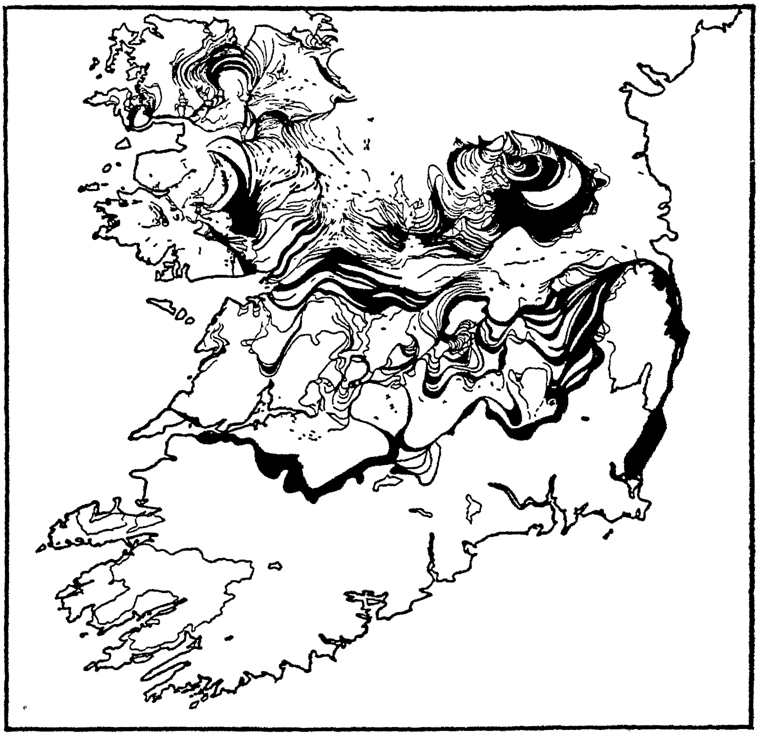

FIG. 77.—The Irish eskers—ridges of gravelly or sandy material of glacial origin. (*After J. K. Charlesworth, Geography, XVI,* 21–27.)

quickly the soils are light and sandy, but the drumlins are often selected in Ireland for agricultural purposes because of the better drainage when compared with the low-lying levels by which they are surrounded.

(*e*) *Brick-earth.*—In the south of England there are some fine loamy or silty soils which are derived from what is commonly called brick-earth. Brick-earth (cf. French *limon*) seems to be in the main composed of the finest particles which result from glaciation, probably distributed partly by wind and thus corresponding to loess, but re-sorted under conditions of heavier rainfall in England,

and so differing in character from typical loess. Soils derived from brick-earth are, however, very fertile.

(*f*) *Gravelly Soils.*—There are numerous sheets of gravel both at high levels and at low levels, particularly in England, some of which may be derived from outwash fans when the ice had melted, others of which are the normal deposits of rivers and some perhaps coastal deposits laid down under marine conditions. The gravelly soils are usually fertile and often give rise to cultivation. Special reference will be made later to cultivation on such areas as the Thames terraces.

(*g*) *Clay with Flints.*—A special type of deposit is widely distributed on the surface of the Chalk Downs, especially the North Downs of Kent. It consists of a stiff clay, brownish in colour, with sharp angular flints. It seems to have been derived as the result of the solution of the Chalk. All the lime has been leached out so that it is a stiff clay soil deficient in lime, commonly, therefore, left to grassland or to damp oak woodland contrasting with the surrounding chalk country itself.

(*h*) *Alluvium.*—The fine grained deposits of the alluvium of flood belts and riverine tracts need no further description, except to point out their wide distribution in this country. To them may be added the finer marine silts such as are important round the Wash.

2. *Mineral Soils derived from the underlying Solid Rocks themselves.*—Two broad divisions may at once be distinguished:

(1) The siliceous soils derived from the older rocks, mainly Palæozoic rocks, of the "Highland Zone" (see p. 25) of the north and west of England and Wales, Scotland and Ireland. Although technically they may be classified into sands, loams and clays, according to the size of the particles, they tend to differ from the better known soils derived from later rocks in the southern and south-eastern parts of England. They are comparatively well drained, but usually lack the fertility of soils derived from later rocks because the weathering processes have failed to form soils of great depth. Where drainage is bad and moisture excessive peat and moorland soils predominate, as, for example, in many parts of the Highlands of Scotland. Indeed the soils of Scotland derived *directly* from underlying solid rocks seem to be limited. Amongst the soils derived from the Palæozoic rocks are extensive stretches of limestone soil, as in parts of the Pennines.

(2) Soils derived from the younger Mesozoic and Tertiary rocks of the "Lowland Zone" (see p. 25) of the south and east of England. Of the Secondary rocks the marls of the Trias and the clays of such belts as the Lias and the later Jurassic rocks, the Cretaceous of the Weald and the Tertiaries (*e.g.* London Clay) give rise to tracts of heavy clay soil. Between these there are the ridges formed by the outcrops of sandstone and limestone. On these will be found

sandy soils, as on the Lower Greensand, and the calcareous soils characteristic of the Oolitic Limestone and of the Chalk. Again, it must be remembered that on these limestones, including the Chalk, leaching is often important and lime may be practically absent. What is often important is the rapid and very marked local variation in many parts of the Lowland Zone, *e.g.* the London Basin.

3. *Organic Soils.*—The distribution of organic soils in the British Isles will have been made clear from the descriptions given above.

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CHAPTER VII

THE LAND UTILISATION OF THE BRITISH ISLES

In England and Wales the Ministry of Agriculture and Fisheries is responsible for collecting and publishing in outline statistics showing the principal uses of the land of the country. In Scotland the same function is performed by the Department of Agriculture for Scotland; in Northern Ireland by the Ministry of Agriculture; and in the Free State (Eire) by the Department of Agriculture. In England and Wales every year "the Minister of Agriculture and Fisheries by virtue of his powers under the Agricultural Returns Act, 1925, requires a return in writing to be made" by each owner or occupier of agricultural land exceeding one acre in area, specifying the acreage of the several crops and of land in fallow or used for grazing, the number of live-stock on the land and the number of persons employed thereon on the 4th June. Similar returns are made in Scotland, Northern Ireland and in Eire. The returns so made are strictly confidential, but the acreages given are added together for each parish and parish figures may be obtained on payment from the Ministry. The published statistics refer to the counties or the administrative counties. In the tables which are published for the counties and in summary form for the country as a whole the terminology if not the classification varies slightly between England and Wales, Scotland, Northern Ireland and Eire. In England and Wales the total area of the country, excluding water, is quoted, then the area under arable land, under permanent grass for hay, under permanent grass not for hay, and under rough grazing. In Scotland the term "mountain and heathland used for grazing" is substituted for rough grazing, and in the summary tables permanent grass is stated as a whole. In addition the Forestry Commission collects statistics of forest, woodland and plantations in England, Wales, and Scotland, so that the acreages of these are available from time to time. In Northern Ireland the summary table shows a division into ploughed land, hay, pasture, grazed mountain land, barren mountain land, woods and plantations, turf, bog and marsh, and other land. In Eire figures are available for ploughed land, hay, pasture, and other lands.

Combining the statistics available and expressing the figures in percentages of the whole areas the following table shows the

utilisation which is made at the present time of the surface of the British Isles:

	Woods and plantations.	Rough grazing land.	Permanent pasture.	Arable.	Other land.
	per cent.	per cent.	per cent.	per cent.	per cent.
England	5·1	11·3	42·8	26·5	14·3
Wales	5·0	33·8	41·8	11·9	7·5
Scotland	5·6	66·8	8·3	15·9	3·4
Eire	1·4	12·0	47·3	21·4	17·9
Northern Ireland .	1·3	15·7	45·6	27·9	9·5

The statistics refer to the year 1933.

The table demonstrates at once certain salient points. In the first place there is the extremely small area actually covered by woods, forests and plantations in all parts of the British Isles. Forest and woodland actually occupy a smaller proportion of the surface in the British Isles than in any other European country. This is notwithstanding the fact that the natural vegetation of the greater part of the British Isles is forest, and two thousand years ago forest must have covered the greater part of the country. Further, it is curious because, to the casual observer, the British Isles still appear to be well wooded. This, of course, is very largely due to the numerous small woods, shaws, and hedgerows with isolated trees, as well as the large proportion of parkland which is so characteristic of the country, especially in the south-east. It must be admitted that the position is little short of a scandal when one has a country which is essentially one which could be forest-covered and which has incredibly large tracts of moorland or heathland which might well be productive of good timber. Furthermore, the woodland that does remain is, from the forestry point of view, terribly neglected. Further reference will be made

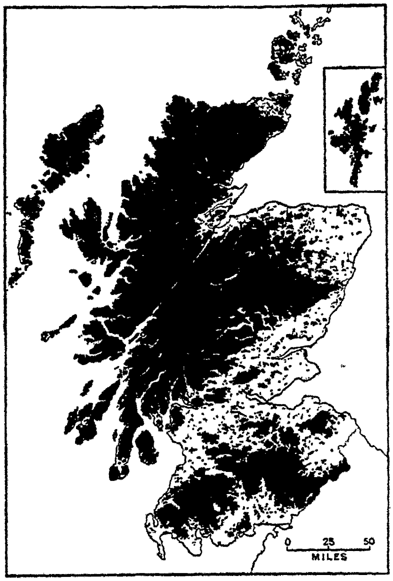

FIG. 78.—The moorland (or rough grazing land, including deer "forests") of Scotland. (*After H. J. Wood.*)

to this subject in a special chapter. The rough grazing land referred to in the second column is for the most part heathland and moorland occupying upland tracts. In England a considerable percentage represents land on the Pennines, the upland areas of the south-western peninsula and the heaths of south-eastern and central England. In Wales the much higher proportion reflects the large extent of moorland in the mountainous areas. It is scarcely surprising to find two-thirds of the surface of Scotland listed as rough grazing land in view of the large extent of the Highlands and of the Southern Uplands. Lowland Ireland, with its improved pastures, has on the other hand comparatively little rough grazing. With regard to the third column, permanent pasture, it will be seen in the sequel that the proportion of permanent pasture is steadily increasing in most parts of the British Isles—at least relatively to the area under the plough. By adding together the figures for permanent pasture and arable land one gets the proportion of the country which may be regarded as improved farming land—nearly three-quarters of the whole in the case of England, only a little over half in the case of Wales, only a quarter in Scotland, but approximately three-quarters in both the south (Eire) and Northern Ireland. Perhaps the most interesting column in this table is the last one, headed " Other land," for which details are not available. It is curious that we should have no statistics or details as to what exactly is the use made of a seventh of the surface of England, which does not fit into any of the preceding categories. Is it waste

Agricultural Census of the British Isles, 1925

	England and Wales.	Scotland.	Northern Ireland.	Eire.
	Acres.	Acres.	Acres.	Acres.
Area exclusive of inland water and tidal land .	37,136,000	19,070,000	3,351,500	17,024,500
Arable	10,682,000	3,229,000	573,800	1,552,000
Permanent grass . .	15,073,000	1,476,000	1,217,300	10,704,000
Rough grazing (private)	1,104,000	9,250,000	514,500	—
Not accounted for in the annual agricultural returns	10,277,000 (27·7% of whole)	5,115,000 (26·8% of whole)	1,046,000 (31·2% of whole)	4,768,000 (28·0% of whole)

This table shows that 72·3 per cent. of the surface of England and Wales is agricultural land of which particulars are furnished annually by owners or occupiers. The corresponding percentages are 74·2 in Scotland, 68·8 in Northern Ireland, and 72 in Eire.

But of the remaining area some at least is agriculturally productive, and an attempt is made in the following table to analyse its character.

AGRICULTURAL CENSUS OF THE BRITISH ISLES, 1925

Estimated areas under types of utilisation not included in the annual agricultural returns

		England and Wales.	Scotland.	Northern Ireland.	Eire.
		Acres.	Acres.	Acres.	Acres.
Area not accounted for in the annual agricultural returns		10,277,000	5,115,000	1,046,000	4,768,000
Agriculture.	Common land and mountain and heathland grazed in common	1,104,000			
	Holdings which escape enumeration	100,000	No particulars available.	No particulars available.	No particulars available.
	Holdings of one acre or less	50,000		10,200	
	Allotments	163,000			
Forest and woodland (Woodland Census, 1924)		1,884,450	1,074,220	40,800	239,500 (1930)
Swamp or scrubland		94,000	No particulars available.	93,400	
Waste or derelict, formerly agricultural		37,000			No particulars available.
Parkland not grazed		10,000			
Commons, heath, and moor not grazed		230,000	3,430,000 [1]		
Prospective building land		13,000			
Recreation grounds		23,000			
Unaccounted for		6,569,550	610,780	901,600	4,528,500

[1] Deer "forests."

land, is it land covered with buildings, or is it moorland which merely awaits improvement and development by agriculturists? The same questions may be asked of the quite large proportion in the other parts of the British Isles.

It was very largely in order to answer the questions mentioned in the last paragraph and to supplement the statistics collected by the Ministry of Agriculture that the Land Utilisation Survey of Britain was formed in 1930, and carried out a survey of the country in the years 1931 to 1939. The aim of the Survey, an organisation whose work was carried out by volunteers all over the country, was to show what use was being made of every single field in the whole of Great Britain. The field work was done on the maps published by the Ordnance Survey on the scale of 6 inches to the mile, since these show the individual fields. The classification adopted by the Survey was drawn up so as to correspond as closely as possible with that used in the official statistics.

Description.	Letter marking.	Colour marking.
(1) Forest and woodland	F	Dark green
(2) Meadowland and permanent grass	M	Light green
(3) Arable or tilled land, fallow, rotation grass, and market gardens	A	Brown
(4) Heathland, moorland, commons, and rough hill pasture	H	Yellow
(5) Gardens, allotments, orchards, nurseries, etc. .	G	Purple
(6) Land agriculturally unproductive, *e.g.* buildings, yards, mines, cemeteries, etc	W	Red
(7) Ponds, lakes, reservoirs, ditches, dykes, streams, and anything containing water	P	Blue

1. *Forest and Woodland.*—Woodland is marked on the one-inch maps and the six-inch maps published by the Ordnance Survey, and the character of the woodland is broadly indicated by symbols showing whether the trees are coniferous, deciduous or mixed, whilst other symbols indicate woodland of a scrubby nature. A classification of British woodland was drawn up by the Forestry Commissioners for the purpose of the Census of Woodlands taken in 1924, and this classification was adopted by the Land Utilisation Survey. Woodland was distinguished first of all into two main categories: (1) economic or potentially productive, *i.e.* woods maintained, or capable of being maintained, for the production of timber for commercial purposes; (2) uneconomic, *i.e.* woods which are not maintained for timber production but primarily for some other purpose, such as amenity woods, shelter woods and parkland timber. The first group is obviously the important one and the Forestry Commissioners and the Land Utilisation Survey have distinguished four types:

(*a*) *High Forest* of trees which are being grown primarily for timber or which can be used for that purpose. When fully grown the trees in the high forest are sufficiently close for their crowns to touch. High forest can be divided into forests of conifers and hardwoods and of mixed conifers and hardwoods. The hardwoods are, of course, the ordinary deciduous trees, but the deciduous larch is included as one of the conifers.

(*b*) *Coppice*, or coppice with standards, woodland that is cut over every 10 or 15 years for fencing, posts, etc. The number of large trees or standards left varies, but they are not sufficiently close for the woodland to be called high forest.

(*c*) *Scrub* consisting of small bushes or trees unfit for the production of timber.

(*d*) *Derelict Forest* which has been cut or devastated. Reference will be made later in the section on Forests (Chapter IX) to the results of the survey of British woodland.

2. *Meadowland or Pasture and Permanent Grassland.*—In the annual returns made by agricultural landholders to the Ministry

of Agriculture and Fisheries, or the Department of Agriculture for Scotland, a distinction is drawn between permanent grassland for mowing and permanent grassland used as pasture. Owing to changes in practice from year to year the distinction was not made by the Land Utilisation Survey, but the category of course excludes rotation grass—grass grown in rotation with crops.

3. *Arable, or tilled, land.*—In any one year land normally ploughed may fall into one of three divisions: that used for clover or rotation grasses, that occupied by crops, and that lying fallow. The three are included together in the maps of the Land Utilisation Survey.

4. *Heathland, moorland and rough hill pasture.*—This type of land is usually distinguished on the six-inch maps and in some cases on the one-inch maps. Swampy or reedy pastures and marshland which can be used as rough pasture have been included here by the Land Utilisation Survey. In the agricultural returns farmers make a return of this type of land, over which they have exclusive grazing rights, but only estimates are available of the areas where grazing rights are communal and of areas of similar character which are not actually used for grazing purposes.

5. *Gardens, allotments, orchards, nurseries, etc.*—In the scheme drawn up by the Land Utilisation Survey houses with gardens sufficiently large to grow a few vegetables, or even flowers, are included in this category; but where there are only back yards or small areas which must be agriculturally unproductive, land used for housing falls into the next category. Allotments are to be regarded as gardens at a distance from the cultivator's house. Large private parks have been split up by the Land Utilisation Survey according to the actual use which is made of the land, much of it naturally being permanent pasture. Orchards and nurseries have been separately shown on most of the published maps.

6. *Land agriculturally unproductive.*—This category includes buildings, yards, railways, mines, cemeteries, as well as waste land, *i.e.* all ground of which the soil is not productively used. On the maps of the Land Utilisation Survey, the difference between land in this category covered with buildings and land which is purely waste is readily apparent because of the presence or absence of symbols for buildings. Where land is temporarily lying waste pending the development of a building estate it has been included under the category of garden land, provided the estate is in course of active development.

It will thus be seen that the work of the Land Utilisation Survey was to show for the years 1931–9 the exact use being made of every portion of the surface. The bulk of the work refers to the years 1931–5, only some of the remoter areas being covered at a later date and the whole was complete before the outbreak of war in September, 1939. The Survey has thus recorded the utilisation of land at a time which may well represent the *nadir* of British agriculture.

The material collected by the Survey is being published in several ways. The coloured one-inch maps (with the same sheet lines and the same base maps, including water and contours, as the Popular Series of the Ordnance Survey) which have been published total 105 sheets (equivalent to 110 sheets of the Popular maps) covering the more populous parts of Britain—the whole of the Midlands, east and north of England, South Wales, and the Midland Valley of Scotland—as well as sample areas elsewhere. Over the remainder of England and Wales the MSS. one-inch maps have been prepared as coloured plates on one-quarter the scale. Finally, a generalised map on the scale of 10 miles to 1 inch, in two sheets, covers the whole of Great Britain.

The details shown on the maps are analysed and the factors influencing present land use and its evolution are studied in detail in the series of county memoirs. This Report, under the title of "The Land of Britain," is being issued in 92 parts, one for each county. Up to May, 1941, 33 parts had been published (in Scotland, Shetland, Orkney, Sutherland, Moray and Nairn, Ayr, Wigtown and Kirkcudbright; in Wales, Anglesey, Merioneth, Radnor, Pembroke and Glamorgan; the Isle of Man; in England, Lancashire, Cheshire, Derbyshire, Shropshire, Hereford, Rutland, Holland, Norfolk, Suffolk, Ely, Cambridge, Hertford, London, Berkshire, Hampshire, Isle of Wight, Wiltshire, Dorset, Somerset and Cornwall). Details are given of historical and economic aspects of land use and special attention is given to factors of permanent importance affecting town and country planning. When the present utilisation is compared with that in the past it is found that on the best and also on the poorest land there is considerable stability of land use (except where housing or industrial development has taken place) but on land of intermediate quality economic factors have completely altered the type of utilisation in the last hundred years. In general the commonest change has been from arable to grassland, but there has been an actual *decrease* in the total of "improved land" despite huge increases in population. In other words "sub-marginal" land, formerly farmed, has been abandoned.

It is also clear, when viewed over the past century and a half, that the natural or geographical factors are of increasing importance. Whereas in the past a country village, cut off by poor communications, had of necessity to grow most of its requirements and did so independently of the suitability or otherwise of local soils and other factors, at the present day conditions of soil and climate determine much more what is economically possible. Starting from a basis of present utilisation it is possible to classify the land according to its inherent fertility, productivity, and suitability for different types of utilisation. A simple ten-fold classification was proposed by the writer and is described in the *Geographical Journal* for December, 1940, thus:—

A1 First Class Arable Land, capable of intensive cultivation.
A2 Good Arable Land, suitable for cash crop production.
G3 First Quality Grassland, fattening pastures and the best dairy pastures.
G4 Good Grassland.
G5 Downland, or Basic Grassland with certain areas (A5) suitable for arable cultivation (usually light land).
A–G6 Medium Quality Farmland, which by reason of slope, climate, or soil cannot become first class but which is or can be productive whether under crops or grass.
G7 Poor Quality Heavy Land.
H8 Mountain or Rough Hill Pastures (Mountain Land).
H9 Lowland Heaths and Moors (Poor Quality Light Land).
H10 Saltings, Rough Marsh Pasture, Wastelands, etc.

The importance of such a classification in any scheme of national land planning is obvious.

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CHAPTER VIII

THE NATURAL VEGETATION OF BRITAIN[1]

IT is frequently stated that except for areas of fenland and marsh the natural vegetation of the whole of the British Isles was forest or woodland, and the small extent of woodland at present remaining —not more than 4 per cent. of the surface of the whole country— is frequently quoted as evidence of the extent to which man has cleared the natural vegetation of the country and artificially altered the appearance of the surface. Whilst it is perfectly true to say that natural woodland has been cleared over vast areas—as, for example, over the Weald of Kent, Surrey, and Sussex—it may be that there is a tendency to exaggerate the former extent of forest land in the British Isles as a whole, and to ignore other types of natural vegetation. Further, when one is discussing the former extent of natural vegetation it is necessary to say exactly to what period one is referring. Before dealing with the different types of vegetation which may be found in the country at present, it will be useful to outline the changes which one may postulate as having taken place since the close of the great Ice Age.

It has already been pointed out that during the great Ice Age ice sheets covered Britain as far south approximately as a line joining the Thames and Severn, and also the whole of Ireland with the exception possibly of certain tracts in the south. Whatever may have been the pre-glacial vegetation of the British Isles, it is clear that the conditions prevailing in the south of both Britain and Ireland at the time of the maximum extension of the ice sheet must have been the conditions of the Tundra lands. With the retreat of the ice and the amelioration of climatic conditions Britain was gradually re-colonised by plant species from the Continent, that is from the south and east. Indeed, there are numerous species still restricted to the south and east, and on the whole the flora of the British Isles becomes poorer in species as one goes northwards and westwards. Just as in northern Russia and Finland at the present day, to the south of the Tundra Belt the dominant trees of the great forests are birch and pine, so we have good evidence that as the ice receded in Britain these were the first trees to invade the country. This

[1] The authors are greatly indebted to Professor E. J. Salisbury, F.R.S., for valued criticism and advice on this chapter.

early post-glacial period of forest is sometimes called the Boreal Period. The birch remained in England, but the pine later disappeared. The pines of the south of England are due to their reintroduction about the eighteenth century, since it is very doubtful whether any of the earlier invaders remained. After the period of the early post-glacial birch-pine forests came the great invasion of Britain by the oak, together with the elm and other deciduous trees, and possibly later still by the beech and the hornbeam. There may have been a post-glacial period milder than at present, and possibly some of the deciduous trees actually extended farther north after their early invasion than they are found to-day. The oak is, of course, found all over Wales, Ireland, and Central Scotland, but the beech does not extend much farther north-west than the Cotswolds,[1] and the hornbeam is likewise restricted to the south and south-east of England. The beech did not, of course, extend over the whole of this region in south-eastern England, it naturally avoids wet soils and is largely restricted to chalk and various light soils, whilst the common oak remains the dominant tree on the tracts of heavy clay. On still wetter soils, alder and various species of willow were the dominant trees. Soil is a much more potent factor in determining the distribution of vegetation types in Britain than it is even in neighbouring parts of the Continent. This is in part because many of the two thousand trees, shrubs, and herbaceous plants are at or near their climatic limits in Britain.

In the time of early Neolithic man (see p. 542) we can thus picture the British Isles as for the most part forest-covered, the types of forest present being determined by climate and by soil, and ranging from forest in the north in which the Scots pine and birch were dominant to the great stretches of oak woodlands on damp soil in the Midlands and south, and to the beech and hornbeam forests of the drier areas in the south. The forest cover may, however, have been interrupted over wide tracts by other types of natural vegetation. Fenland and fresh-water marshland probably covered very large areas, such as in the region still known as the Fens, of which a description will be given later. Proofs exist that much of the heathland and moorland of the present day was formerly forested, but this may not apply to the whole of the great areas that are now moorland. Scrubland, which can be defined as the transition phase between grassland or heathland and forest, may also have covered very considerable areas. It is much more difficult to assess how far grassland may be regarded as a natural type of vegetation in Britain. At present there are three or four kinds of grassland which correspond broadly with the main types of forest.

[1] Except, of course, when planted, when it is found growing well in North Wales and in Scotland at least as far north as Moray and Nairn.

Thus the chalk grassland which is characteristic of the shallow soils derived from the chalk corresponds with the beech forests found on the same soils. These chalk grasslands may have been typical sheep pastures from very early times, whilst more recently the ravages of rabbits and other small grass-eating animals have contributed to prevent the growth of forest on these upland tracts.

It may have been the more open character of the vegetation on the higher limestone tracts made them attractive to the Neolithic settlers. There is no doubt that the Neolithic settlements occurred in such areas, and early Neolithic roads are found for the most part on such elevated tracts, despite difficulties of an adequate water supply (see p. 543). Another type of grassland, often called grass heath, occurs on sandy soils and shows many transitions to and from heath proper. A third and very common type of grassland is that which is called neutral grassland, and which corresponds to the oak forests of the heavy clay lands. This on alluvial soils, or where the water level is high, passes naturally into water meadow, corresponding broadly with the willow and alder woodlands.

There can, however, be little doubt that much of the grassland of the present day owes its character to human influence.

An attempt will now be made to describe very briefly some of the more important types of the natural and semi-natural vegetation which are found at the present day in the British Isles. Before doing so it will be well to understand the principle involved in plant succession. Each type of physical environment, that is each combination of climate, soil, etc., may be regarded as having an association of plants peculiar to itself, and this plant association would form the natural vegetation cover, provided interfering factors are absent. This natural vegetation association is known as the climax association, but it must not be supposed that a tract of country, such as Britain must have been when the ice sheet left it, or a tract of land which has been cultivated by man and then deserted, will immediately become covered with the climax association. It is instead invaded and colonised by plants whose dominance is limited in that they will in time become ousted by others until the climax community eventually establishes itself. Thus the natural vegetation cover passes through a succession of stages; owing to the depredations of animals such as rabbits, the interference of man and his domestic animals, certain of the stages in the plant succession may become quasi-permanent and the climax community may not have an opportunity of establishing itself at all. Thus in attempting to describe the natural vegetation cover of the British Isles we shall be dealing with various stages in the plant succession as well as climax communities.

Referring to the table given on p. 109, showing the utilisation of the surface of the British Isles, we may regard natural and semi-

natural vegetation as embracing the first two categories—namely, the woods and the rough grazing land, which broadly speaking is moorland and heathland, and at least to some extent the permanent pasture—whilst under the heading of other lands are included certain areas of marsh, etc., which are definitely natural vegetation.

TYPES OF NATURAL VEGETATION

The following brief account of the chief types of natural vegetation found in the British Isles has been based in part upon the standard work on the subject, entitled *Types of British Vegetation*, edited by A. G. Tansley.[1] For details reference should be made to this work and also to the numerous papers which have appeared in the pages of the Journal of Ecology—the journal of the British Ecological Society. The types have been arranged in the following summary under the three broad headings of forest and woodland, heathland and moorland, and grassland, and thus correspond with three main categories which have been distinguished in the maps of the Land Utilisation Survey of Britain. Thus the types described under forest and woodland will include the principal types of natural vegetation to be found in those areas coloured dark green on the Land Utilisation maps. Similarly the type described under heathland and moorland will be the types which make up the areas of yellow colour on the map, whilst the types described under grassland will be those which correspond to the light green areas on the Utilisation maps.

I. Forest and Woodland

(1) *Damp Oakwood or Pedunculate Oakwood.*—In more ways than one the oak is the characteristic British tree, and there can be little doubt that the whole of the lowlands of Britain with clayey or loamy soils were at one time covered with oak forests. Most of the woods still existing on these soils, with the exception of those, of course, planted with exotic species, are also oakwoods or derived from oakwoods. The dominant tree on the heavier soils and those well supplied with mineral salts is *Quercus robur* (*Quercus pedunculata*), or the pedunculate oak. Most of the British oakwoods have been heavily exploited for timber in the past.[2] Oak was in special demand for shipbuilding before the extensive use of iron and steel. The rise of the English Navy and Mercantile Marine coincided with a rapid using up of extensive oak forests, particularly in the south-east of England, where the oak forests were within easy reach of navigable waters and harbours. During the Middle Ages, too, when most of the iron was smelted by means of charcoal, there was an

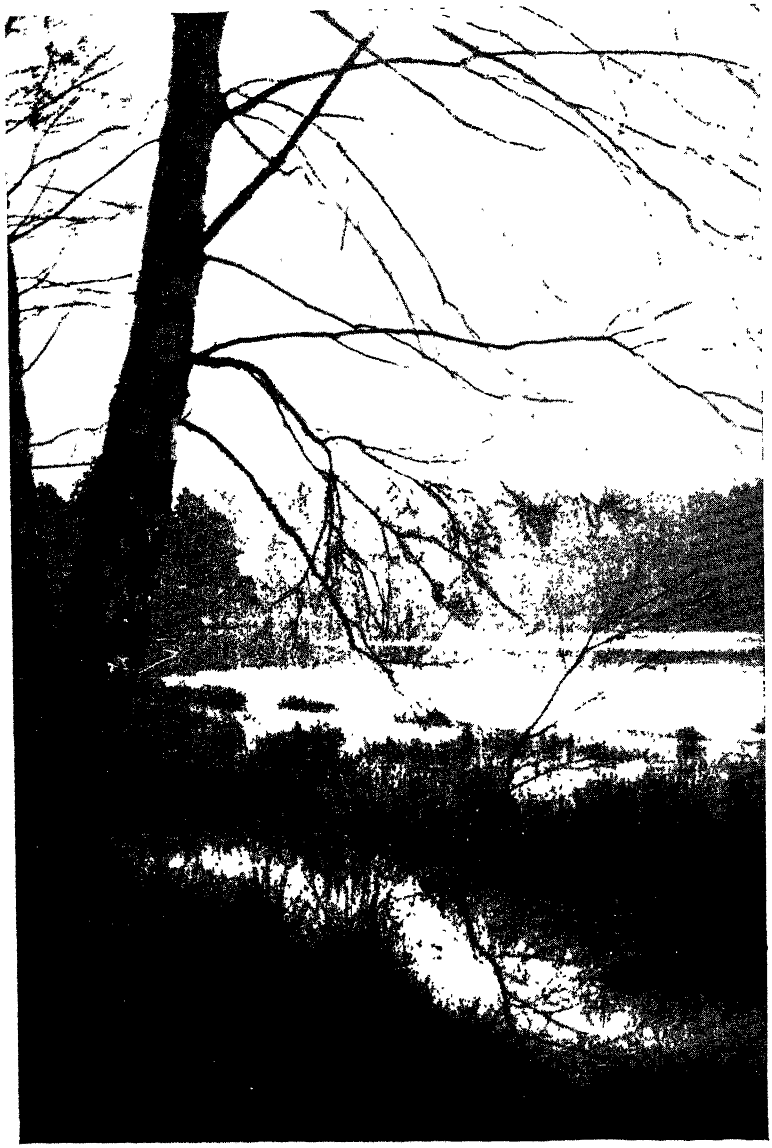
[1] Now superseded by *The British Islands and Their Vegetation*, 1939. See below, p. 130.

[2] Primitive woodland can frequently be distinguished even from very old

enormous destruction of oak forests. It is of course well known, as explained elsewhere in this book, that the disappearance of the Wealden iron industry is not due to the exhaustion of the ore, but to the virtual exhaustion of the supply of wood for charcoal. Most of the oakwoods which remain have been sadly neglected from the forestry standpoint and really good standard trees, suitable for the production of timber, are few. In the south and midlands of England the majority of oakwoods are now in the form of coppice with standards. That is to say there are some eight to a dozen " standards " or large trees per acre, whilst the intervening area is occupied by " coppice," trees of other species. By far the most common of coppice trees is hazel. It is encouraged to branch near the ground, and after a period of ten or fifteen years the main branches thus formed are cut for the provision of fencing posts, etc., the smaller ends having a small market as bean sticks and pea sticks. Ash and birch are also common in coppice woods, and oak itself may be coppiced, in addition to the oaks which grow as the standard tree. Another important coppice tree is the Spanish chestnut, much favoured for fencing because it splits evenly into two half-round sections. It is urged by some that these woodlands of coppice with standards are legacies from the Middle Ages when the oak woods were thinned in such a way that the remaining trees branched freely and thus gave a supply of curved timber and " knee " pieces which were particularly useful in shipbuilding; obviously quite contrary to the usual requirements of modern industry of good straight timber. The copse or coppice with standards will obviously present a very different appearance shortly after it has been cut, and a recently cut woodland is usually characterised by a rich growth of ground plants, including the favourite primrose and bluebell. These almost disappear as the coppice trees once more grow up and cast a greater shade over the ground. The wood anemone and dog mercury are other characteristic ground plants. " On the edges of burnt oakwoods which have been carelessly exploited a scattered scrub is commonly found with spaces of turf between the clumps of bushes and an occasional isolated oak tree. This vegetation represents degenerate oakwood from which the trees have nearly all quite disappeared." Many of the species present in this scrub are spiny species, and this is doubtless due to the fact that they are protected by their spines from browsing animals. This kind of land is occasionally used for pasturing, but has economically no value as woodland (recorded by the Land Utilisation Survey as Fc).

(2) *Dry Oakwood.*—Oakwoods also occur on dry sandy soils. The oak may either be *Quercus robur* or *Quercus sessiliflora*, or the two may be mixed. Birch is usually found in the dry oakwoods in varying proportions, but the hazel and the ash are usually

absent. The ground vegetation is usually poor, but a common feature is the presence of large quantities of bracken. The beech may occur, particularly in societies or clumps, and as usual in beechwoods the undergrowth is here almost absent. Scrub may



[*Photo: L. D. Stamp.*

FIG. 79.—A Surrey Common.

Birch-heathland, with sub-spontaneous pinewoods in the background—a view taken a hundred yards from a main road within twenty miles of London.

occur on the margins of these dry oakwoods, and the woods, especially oak with birch, often grade insensibly into heathland. Reference will be made later to the oak-birch heath.

(3) *Sessile Oakwoods* (Durmast Oakwoods).—On the older rocks of the British Isles, which, as already described, furnish poor siliceous soils, oakwoods again occur, but here the dominant tree is the Durmast oak, *Quercus sessiliflora.* The soils are shallow and are usually deficient in soluble salts, especially calcium, and often show a marked tendency to allow the accumulation of acid humus. Durmast oakwoods occur, however, on a great variety of soils, but always with soils poor in mineral salts. The trees are therefore on the whole of small dimensions; where larger, the trees are of a more upright habit [1] than *Q. robur.* The birch (*Betula tomentosa*) commonly occurs, the beech is sometimes found in larger woods. Conifers are not indigenous, but both the larch and the Scots pine are commonly planted. The holly (*Ilex aquifolium*) is usually found in the oakwoods on the Pennines. On the hills, such as the Pennines and in Wales, it would seem that these oakwoods formerly extended to higher levels than at the present day. They tend to degenerate now into scrubland and there is every passage from scrub to grassland and moorland. In the intermediate stages, especially on the drier soils, bilberry and bracken are very common. In the Pennines and drier regions the ash is usually confined to wetter situations and the sides of streams, but in the regions of the British Isles which have a heavy rainfall, for example in the Lake District, most of the oakwoods contain a very large proportion of ash, and one really has an oak-ash woodland. The same is true, for example, of some of the Devonshire woods.

(4) *Birchwoods.*—Anyone who knows the great northern forests of Russia and Lapland will know the extent to which the birch is there intermingled with hardy coniferous trees. It is not, therefore, surprising to find a fringe of birchwood occurring above oakwoods in the British Isles, and forming in the Highlands of Scotland characteristic woods at the sides of the valleys, sometimes even occurring up to elevations of 2,000 feet. The birch is a light demander, but can stand great exposure. Oakwoods from which the oak has been removed are often replaced by the less valuable birches and become birchwoods, whilst wood clearings often seem to pass into birchwoods rather than back to the original oakwoods. Thus the birchwoods may replace the oakwoods or may occur definitely as a vegetation layer above them.[2]

[1] These oakwoods may be coppiced on a twenty-year rotation.

[2] It has been pointed out by Professor E. J. Salisbury that primitive man, working with stone tools, would find the birch easier to cut down than oak, and it may be that he was attracted to higher ground in many parts of Britain, not because the ground was already clear but because the birch forest was more easily cleared.

(5) *Pinewoods.*—Although, as mentioned above, the Scots pine (*Pinus sylvestris*) was formerly native in many parts of England and Ireland, it is generally agreed that it disappeared from the south of England, and has only recently been reintroduced (in the eighteenth century or perhaps earlier). In Scotland pinewoods at one time covered large areas in the broad valleys or straths of the Highlands and the glens, extending for considerable distances up the mountain slopes. Owing to heavy exploitation the area occupied by these pine woodlands is now rather seriously restricted. On its introduction into the south of England the Scots pine spread very rapidly over tracts of sandy soil, and it now forms extensive sub-spontaneous woodland, as on the Bagshot Sands of the London Basin and on the Lower Greensand of the Weald. But whether in Scotland or in the south of England, there is a very close association between pinewoods and heathlands, and it is often difficult to decide whether an area should be classified as a pinewood, or as heathland with many scattered pines. It will be seen that on the dry soils of the south these pinewoods are competitors with dry oakwoods and with beechwoods. The close pinewoods are very poor in other species, partly on account of the deep shade and partly because of the thick layer of pine needles which carpets the floor of the woods. Where more open, bracken is common, whilst over large areas the bilberry (*Vaccinium myrtillus*), as in the great coniferous forests of the north of Europe, is very characteristic, associated of course with the heath (*Calluna vulgaris*).

(6) *Beechwoods.*—There is some doubt as to whether the beech (*Fagus sylvaticus*) was introduced about the time of the Romans or if it is native to the country. Beechwoods occur characteristically on the chalk, occupying the steep valley sides or the scarp faces on the North and South Downs as well as large areas in the Chiltern Hills and in parts of the Cotswolds. They are absent from the northern chalk areas of Yorkshire and Lincolnshire as well as of Norfolk. It is held by many that this distribution supports the idea that the beech is a comparatively recent immigrant from the Continent. On the Continent the beech tends to occur rather on the marly or damper limestone soils. In England the beech is natural to the drier limestone soils, possibly as a result of the generally damper character of the English climate. The way in which the beechwoods occur on the steep sides of the chalk valleys has given rise to the commonly applied name of " hanger " for this type of wood. The beech is not only the dominant tree in the beechwoods, it is very frequently the only tree, and indeed typically forms pure high forest in close canopy. Shrubs and ground vegetation are scarce, in fact the latter is often quite absent, and the ground covered with nothing but the delightfully brown fallen leaves. Thus, walking through a beechwood, there are many characteristic

points of difference to be noticed from other types of English woodland. Occasionally the yew occurs as a shrub in the beechwood forest, and locally the yew has become dominant and forms yew-woods. Beechwoods are not restricted to the chalk; the beech has migrated to lighter sandy soils, much more rarely is it found on heavier clay soils. It is essential that there should be free drainage round the roots. The beech cannot grow with its "feet in water."

(7) *Ashwoods.*—Ashwoods are characteristic of limestone soils in the north and west of England, where, as already pointed out, beechwoods are absent. They are thus well-known features of the limestone dales of the Carboniferous Limestone of Derbyshire and of the Mendips. Wych elms are commonly found in these ash-woods whilst shrubs are characteristically abundant (including a number of species), partly owing to the high light intensity, even in summer, resulting from the translucent canopy of the trees. On marly soils the oak becomes important and one may really distinguish an ash-oak woodland association as characteristic of marls and calcareous sandstones. Again, hazel is common, and where the oaks have been left as standards one may have an ash-oak-hazel coppice, very common indeed in the south of England, especially towards the rather damper west, taking the place of the oak-hazel coppice, which occurs on clay soils which are poor in lime.

(8) *Alder-willow associations.*—The alder (*Alnus rotundifolia*) and the willows (*Salix*) are the characteristic trees of very damp situations. By the sides of streams in oakwoods the alder usually appears, whilst the alder-willow association is the woodland association which corresponds to marshland.[1] The osier (*Salix viminalis*) is of course usually planted—on tracts of alluvium by the sides of rivers where the surface of the ground is only a few inches above the permanent water level. The ground vegetation in such situations is that of a typical marsh. In the wet areas of East Anglia the woodland formation, occurring associated with fens, is known as swamp carr and marsh carr.

II. Heathland and Moorland

Under the title of Rough Grazing, Mountain Heath, Moor or Downland, the published statistics of the Ministry of Agriculture and Fisheries include a considerable variety of types of natural vegetation. This category is identical with the Heathland, Moorland, Commons, and Rough Hill Pasture distinguished by the Land

[1] Professor E. J. Salisbury believes that alder woodland was formerly very widespread in low, damp ground, but, because of the relative ease with which the alder could be cleared by primitive man with stone tools, was largely destroyed at an early date. Compare the early settlements on valley gravels (see p. 557) where the lowland water meadows were an added attraction.

Utilisation Survey of Britain and shown on their maps in yellow. Amongst the chief types may be distinguished the following :

(1) *Heathland or Heath Associations.*—In heathland by far the most widespread and abundant species is ling or heather (*Calluna vulgaris*). With it are usually associated other members of the Ericaceæ of which *Erica tetralix* is one of the commonest ; whilst towards the north of Britain the bilberry (*Vaccinium myrtillus*) becomes dominant over considerable tracts. Under the dense shade of *Calluna* very few other species can exist. Heathland is usually found on gravelly or relatively coarse sandy soil, or on similar soils derived from the older rocks in the north. The coarse, gravelly or sandy soil usually has a dark surface layer coloured by much humus, below which there is a layer of leached sand, often pale-grey, or even whitish in colour. Between this and the unaltered sands below there is frequently a compact stratum of hard moorpan. The moorpan may be only a few inches but perhaps several feet below the surface, but it is this which prevents the invasion of heathland by trees, and heathland in which the hard pan is present cannot be afforested unless the pan is broken up or holes made in it for the roots of young trees to penetrate. Thus the heath association is usually a stable association, either resulting from the final degeneration of the oak-birch-heath association or a stage in the succession on poorer sandy soils. Where the hard pan is absent there may be every gradation from the pure heathland to the oak-birch association, or to the association of pinewoods. It is frequently difficult in studying a tract of country to decide what should be called pinewoods with a ground vegetation of heather and heathland with scattered pine trees. Indeed any distinction must be a very artificial one. Gorse is often found on the margins of heathland where conditions are less acid, though it is not essentially a typical member of the heathland itself. Local bogs are common in heathland. Some of the better known regions of English heathland include the stretches of flat sandy country in north-west Norfolk, and south-east Suffolk on the crags or on the more sandy members of the overlying drift deposits. Heaths are well developed on the Bagshot Beds of the London Basin, and on the sandy Tertiary beds of the Hampshire Basin. They are common, too, on the sandy bands which occur in the Wealden area. Both the sandy soils of the New Forest region and the sandy soils of the Weald afford an excellent example of the way in which heathland dovetails into the oak-birch woodland and pinewood. In the west heathland occurs both on Devonian Sandstones, as on Exmoor, or on the granite masses, such as Dartmoor. Here, being in the wetter part of the country, there is frequently a gradation into true moorland. In Yorkshire the name " moor " is often applied to true heathland, and here varieties have been distinguished according to the dampness of the areas.

Heathland in Scotland does not usually occur at greater elevations than 2,000 feet, and is found in those parts of the Highlands where the mean annual rainfall is comparatively low—less than 60 inches. The heathlands of the Highlands are usually called moors, and are indeed the typical grouse moors. As such they are systematically burned in rotation every ten to fifteen years. In various regions, the association of bracken with typical heathland should be noticed.

(2) *Limestone Heathland.*—In the ordinary way heather is a plant that dislikes lime, and it is not therefore found on calcareous soils. But some plateau areas of limestone, owing to leaching action, tend to lose their lime, and consequently in such areas heather may occur, but it is associated with plants which have long roots, and which therefore reach the limestone below and are thus lime lovers. This accounts for some heath-like vegetation occurring in limestone areas. Of rather a different order are the limestone pavements which occur as striking features on some of the summits of the Carboniferous Limestones, as in the north Pennines and in the great limestone plain of County Clare in western Ireland. The exposed surface of the rock is very bare, and although rather rich in mosses it is extremely poor as regards larger plants which are more or less restricted to crevices. Heather (*Calluna*), though a calcifuge, may be present partly because of the existence of little pockets of soil from which the lime has been leached.

(3) *Moorland.*—Moorland is a comprehensive term, and includes many different types of natural vegetation. Moorland is essentially the vegetation of peaty soils. Frequently the soil is deep, practically pure peat; in other cases there is only a shallow layer of surface peat much mixed with mineral substances from the underlying rocks, in which case there is naturally a transition stage between the moorland and heathland, as one finds in the "moors" of the North Riding of Yorkshire. There are also peat soils, especially those relatively rich in lime and developed particularly, as far as Britain is concerned, in East Anglia, to which the name black fen is frequently applied. Separating moor and fen, moor has a relatively wet peat soil of considerable depth, fed by water poor in mineral salts, suffering from lack of aeration so that the humic acids produced give rise to a soil water which is acid in reaction. Fen, on the other hand, has a peat or peaty soil fed by water which is relatively rich in mineral salts, with the result that the ground water is alkaline in reaction. When drained, the peaty soil of the fens gives rise to a very dark coloured but extremely rich soil; whereas even when drained it is difficult to carry out cultivation on many tracts of moorland because of the essentially acid nature of the soil. In moorland a broad distinction is possible between lowland moors, such as those areas known as "mosses" in Lancashire, and upland moors. *Sphagnum* is a very common constituent of lowland moors

[*Photo: L. D. Stamp.*

FIG. 80.—The Moor of Rannoch, Argyllshire, Scotland.

Showing one of the innumerable small lochs. The hills (part of the Grampians) in the distance are covered with *Scirpus*-moor and Heather-moor.

and in the valley moors which occur in the south of England in the wetter parts of heathland. Amongst the different types of upland moor which have been distinguished in the wettest areas there is the *Sphagnum*, or bog moss moor, of comparatively limited extent. The cotton grass moors are characterised by the cotton grass (*Eriophorum vaginatum*) and are much more extensive in their occurrence. Cotton grass moors are widely distributed on the summit plateau of the Pennines, and sections through the peat of these areas show that considerable areas of these moorlands were once forested. *Scirpus* or reed moors occur in the wetter regions of the north-west Highlands of Scotland, as well as in some parts of Ireland, such as the Wicklow Mountains. The dominant plant is *Scirpus cæspitosus* with often a considerable quantity of heather. There is evidence that some of these moors, too, were formerly forested, the remains of Scots pine and birch having been found in the peat.

(4) *Bilberry Moors.*—The dominant plant here is *Vaccinium myrtillus* (the bilberry) and this type is common in the Pennines and in the central part of the Highlands of Scotland, but not in the north-west nor the Hebrides.

(5) *Heather Moors.*—These differ from the heathland mainly in the occurrence of a greater thickness of peat, and the frequent association of heather and cotton grass or heather and bilberry.

(6) *Grass Moorland.*—Grass moorlands cover large areas of Boulder Clay, such as in the southern part of the Southern Uplands, and also in the western Highlands of Scotland. The grass moorland tends to be intermediate in character between the *Scirpus* moor, already described, and siliceous grassland. The vegetation is mainly composed of a variety of grasses, rushes, and sedges, but as in other moors, the soil is peaty, acid, and generally wet during most of the year.

III. Grassland

Five or six main types of grassland may be distinguished and may be regarded as semi-natural formations in that they correspond with different types of woodland, and are found where the woodland has been cleared.

(1) *Neutral grassland.*—The adjective "neutral" indicates that the soil of these grasslands is neither very acid on the one hand, nor particularly calcareous on the other. The neutral grassland is the ultimate phase of degeneration of damp oakwood and so occurs associated with damp oakwood on the same types of soil. It consists of a close turf of grasses with associated herbaceous plants. The plants characteristic of calcareous pasture on the one hand are absent, and so are those which are characteristic of heath pastures. Neutral grassland affords excellent permanent pasture

and is usually heavily grazed, but where less heavily grazed, as on the borders of some of the village greens of central and southern England, has many of the plants common to the ground flora of the damp oakwoods, including the anemone and the primrose. Where clay soils are low lying, and ground water approaches the surface, the appearance of various species of rush (*Juncus*) may be noticed in neutral grasslands and marks a gradual passage towards rough marsh pasture. The line is often very difficult to draw, and this was found to be the case in surveying for the Land Utilisation Survey. The best neutral grasslands are the permanent pastures dominated by rye grass (*Lolium perenne*) and wild white clover (*Trifolium repens*).

(2) and (3) *Acidic grasslands.*—Grassland dominated by bents (*Agrostis* spp.) together with sheep's and red fescue (*Festuca ovina* and *F. rubra*) probably covers a greater area than any other type of grassland in Britain. It is the typical community of the "grass-heath" and "siliceous grassland" of earlier writers. Grass heath is associated with dry oakwood. Although transitions to ordinary heath are found, in the grass heath true heath plants, such as *Calluna*, *Erica*, etc., may be, and usually are, entirely lacking; but the grasses are those which prefer a sandy soil and usually form a close short turf. These grasslands are less valuable as grazing lands than the neutral grasslands, and so one often finds patches of gorse coming in on the margins of such areas. The East Anglian "heaths" sometimes include quite considerable stretches of dry grassland of this character, and it is believed by some writers that they represent a survival of steppe, or semi-steppeland, conditions in Britain.

The better "siliceous grasslands" correspond with the sessile oakwoods which occur on the thin soils of the older rocks. In such areas as the Pennines they tend to occur, not only associated with the oakwoods, but at higher levels. On poorer drier areas the characteristic grass is the mat grass (*Nardus stricta*); whilst on the wetter soils the purple moor grass (*Molinea cærulea*) is the characteristic grass. In the south-west, the characteristic grass is *Agrostis setacea.* The dominance of grass is sometimes interrupted by stretches of bracken, whilst the small gorse comes in abundantly in such areas as the Malvern Hills, Devon, and some of the hilly areas of Ireland. In wet areas rushes appear.

(4) *Limestone or Basic grasslands.*—Everyone is familiar with the springy turf that is characteristic of the chalk downs and commonly referred to as downland. Similar grassland is found on most limestones in this country. The grasses of the siliceous grasslands are absent, and the bracken, the gorse, and the rushes are on the whole uncommon. The heaths, too, are practically unknown. No one who is familiar with the delightful chalk downlands in the south of England will need to be reminded of the characteristic

herbaceous flora, with numerous flowering herbs peculiar to itself, including many of our orchids. Generally the dominant grass is the red fescue (*Festuca rubra*). Although a great proportion of the chalk pastures in England are old, it is going too far to say that the area has never been occupied by woodland. The chalk and limestone grasslands have, of course, long been famous as sheep pastures. Rabbits also are very abundant, and where they do occur in numbers the turf is even more closely nibbled than by the sheep. The fescue, with its wiry herbage, is very largely responsible for the springy nature of the turf, which is thus so delightful for walking.

(5) *Arctic-Alpine grasslands.*—This type of grassland is practically restricted to the higher levels in the Highlands of Scotland. The grasses and other plants tend to have a rosette habit, and naturally the species occurring are of particular interest in view of what has been said above as to the possible origin of this vegetation. This, with certain very wet types of grassland, may be the only type of *natural* grassland in Britain.

IV. Fenland and Fresh-water Marshland

The vegetation of fens, fresh-water marshes, mosses and bogs is ecologically very interesting but economically unimportant. Some very reedy pastures are intermediate in character and can be used for rough grazing, but the true fen and fresh-water marsh are of little use except for the yield of rushes for such purposes as thatching.

V. Salt marsh

The vegetation of regions which are characterised by the presence of salt in the soil or which are periodically flooded by salt water, whether under the influence of the tide or occasionally, consists of plants specially adapted to withstand these curious conditions, and known as halophytes. They are commonly fleshy plants of which the glassworts (*Salicornia*) are particularly characteristic. Some of the drier types of salt marsh can be used for occasional pasture. The numerous types of salt marsh are of particular interest to the ecologist, but are rather outside the scope of the present work.

VI. Sea Coast and Sand-dune Vegetation

Hard, wiry grasses are characteristic of the vegetation of young sand-dunes. Some of them are particularly valuable because of their ability to bind sand-dunes and prevent their movement over valuable land. The sea couch grass (*Agropyrum junceum*) and the marram or star grass (*Ammophila arundinacea*) are specially interesting in this connection. Occasionally a few goats find pasturage on sand-dune grasses, and there is quite a considerable use of older dunes as golf courses. The study of grasses suitable for planting as greens for the golf courses is thus a matter of some general interest.

5

It might be thought that the study of the natural and semi-natural vegetation of the British Isles has comparatively little practical importance. This, however, is very far from being the case. The natural vegetation of an area, in fact, forms a perfect index of the sum total of conditions, particularly of soil and climate, which affect the growth of any plants which may be introduced by man. For example, in introducing foreign species of trees for afforestation experiments in Britain it may be essential that they should be introduced in regions where the environment corresponds with the environment where they are found to flourish in their own home localities. The character of such environment in this country can be gauged by the natural vegetation ordinarily existing.[1] Further, a detailed study of the natural vegetation existing, for example, in our moorland tracts, is an indication as to what is wrong with the soil from the point of view of its further utilisation in other directions, *e.g.* in agriculture. The presence of reeds in ordinary meadows is definitely indicative of wet conditions. The occurrence of heath is clearly indicative of an entirely different set of conditions. It is to be feared that some of the expensive experiments in afforestation have been carried out without a sufficient study of the local natural vegetation.

REFERENCES

In 1939 the Cambridge University Press published the magnificent volume of nearly a thousand pages and 162 plates entitled *The British Islands and Their Vegetation* by A. G. Tansley. Professor Tansley, editor of the *Journal of Ecology* from 1916 to 1937, had previously edited *Types of British Vegetation* (published in 1911, but for many years out of print) which for over a quarter of a century had been the standard work. The new book not only includes the subject-matter of the *Types* but incorporates a summary of all later research and, in addition, an extensive geographical introduction which the geographer will do well to read for its own sake. Before the inception of the British Ecological Society papers dealing with ecology and plant distribution appeared in various botanical and geographical journals. See especially R. Smith, "Botanical Survey of Scotland," *Scott. Geog. Mag.*, XVI, 1900, 385–416, 441–467; XX, 1904, 617–628; XXI, 1905, 4–23, 57–83; (with M. Hardy) XXII, 1906, 229–241; also C. E. Moss: *Vegetation of the Peak District.* Cambridge University Press, 1913.

For modern methods of study see A. G. Tansley, *Practical Plant Ecology.* Cambridge University Press, 1926.

In recent years Sir George Stapledon has initiated several surveys of grassland (see below, pp. 192–3) adopting a broad classification which is both ecological and agricultural. See especially William Davies in *A Survey of the Agricultural and Waste Lands of Wales* (edited by R. G. Stapledon), 1936, and R. G. Stapledon, *The Hill Lands of Britain, Development or Decay?*, 1937.

[1] On the other hand, other exotic species when introduced (*e.g.* some Alpine species) are found to require different conditions.

CHAPTER IX

FORESTRY AND AFFORESTATION[1]

ENOUGH has been said in the chapter on Natural Vegetation to indicate that the climate of the whole of the British Isles is one favourable to the growth of forests, and that one must regard forests as the natural vegetation cover of the major part of the islands. As we travel about much of Britain, particularly the lowland counties of England, the southern part of Scotland, the valleys amongst the Highlands, as well as the valleys of Wales, we are, perhaps, impressed by the well-wooded nature of the country. But the impression is in reality an illusion, for not five per cent. of the surface of the British Isles is at the present day covered with forest and woodland (see p. 133). The lowlands of Britain are, of course, pre-eminently characterised by numerous small fields, usually separated by hedges, and almost inevitably one sees along these hedges isolated trees which are all that remain of a once continuous forest cover, or, more often, these isolated trees were planted at the time of the Enclosures. Viewed from a distance, the isolated trees of the hedgerows and the scattered trees of our numerous parks give an impression of a well-timbered country which is in reality entirely false. Yet in the past forests have played an important part in the economic life of Britain. In the early days the clearing of heavily forested land, particularly the damp woods of the lowlands, presented a task beyond the capacity of the early inhabitants of these islands. Nor did they appreciate their fertility until the knowledge of drainage became widespread. In the Middle Ages the products of our forests and woodlands played an essential part in the economic development of the country. To quote from an article written a few years ago[2]: "The three great uses of wood in the pre-industrial period may be broadly said to be for construction, for domestic fuel and for industrial fuel. In the days when timber occupied a place in domestic architecture even more fundamentally important than it does to-day, when timber was the only material for the construction of ships and when timber rubbed against timber in the

[1] The authors are much indebted to Mr. Ray Bourne of the School of Forestry (University of Oxford) for his valued comments on this chapter.

[2] L. D. Stamp: "The Forests of Europe, Present and Future." Paper read before the Forestry Subsection, British Association, Glasgow, September, 1928; published in the *Empire Forestry Journal*, VII, 1928, 85–102.

moving parts of the coach or the mill wheel, it was strength and durability which counted rather than ease of working. Consequently the old oak beams of the manor house, the massive timbers of the *Victory*, or the elaborately carved panels of a Jacobean sideboard are symbolical standards of value which were the essential standards of the Middle Ages. The emphasis is obviously on the hard woods rather than on the soft woods. The association of the latter is rather with the blazing pine logs of the baronial hearth—the second great use of wood in the Middle Ages. Characteristic of the third great use is the now defunct iron industry of the Weald. The presence of large quantities of wood suitable for the manufacture of charcoal was the first consideration in determining the location of numerous industries, of which the smelting of iron was one."

The Industrial Revolution may reasonably be held to include the development of coal (including gas and electricity derived therefrom), and later of oil, as the principal domestic and industrial fuels and the rise to first rank of iron and steel as constructional materials. It would almost seem as if timber had become a superfluous commodity. Entirely supplanted by iron and steel in the construction of ships and machinery, very largely replaced in countries such as England as a domestic fuel and entirely as an industrial fuel, timber seemed to have been relegated to a position of minor importance in the economic life of the world.

The history of forestry in the nineteenth century reflects the unconscious reaction of these changes on the public mind. The reckless depletion of forests by unregulated felling; the "clearing" of enormous areas for agriculture by the incredibly barbarous method of burning off virgin forest; the lack of precautions against fire, and a dozen other things too familiar to necessitate enumeration, all indicate the low ebb of public appreciation of forest wealth.

But the present era is by no means an era which can do without forest products. There are innumerable new uses absorbing huge quantities of timber, such as requirements for railway sleepers, telegraph poles, pit props, as well as the constant demand for the time-honoured purposes of domestic architecture and the construction of furniture. There is the huge and ever-increasing quantity of timber which is required for pulping and manufacture of paper.

The peculiar and serious position of Britain may be judged in several ways. In the first place there is the remarkable contrast with the remainder of Europe. Europe as a whole has roughly 31 per cent. of its surface covered with forest, an average of about $1\frac{3}{4}$ acres of forest for every inhabitant. Compared with the other countries of Europe, the United Kingdom is in the anomalous position of having the smallest proportion of forest area, as well as the smallest area *per capita*, of any country. The useful forest

and woodland covering the surface is only about 4 per cent. of the whole and is equivalent to only about one-tenth of an acre per inhabitant. Europe, excluding the British Isles, is roughly self-supporting in the matter of timber, but there is certainly not sufficient surplus to supply the huge requirements of this country. The bulk of our requirements of all kinds must be imported, and in the years immediately preceding the War over 25 per cent. came from Canada and the United States. Figures are given in the paper just quoted to show that forest supplies have been so depleted

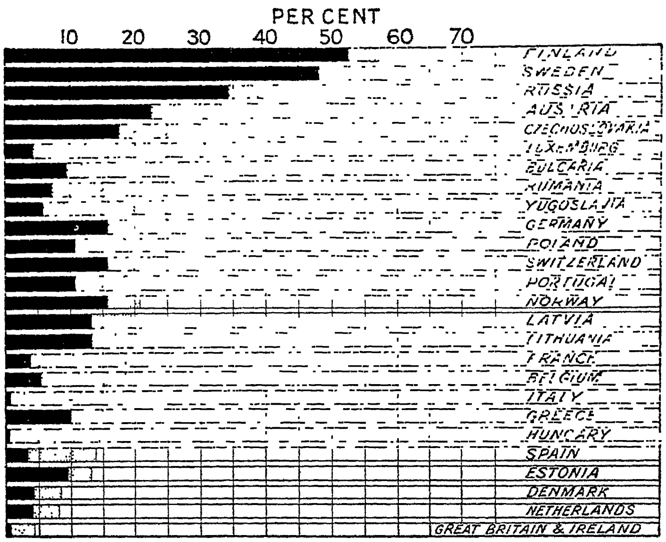
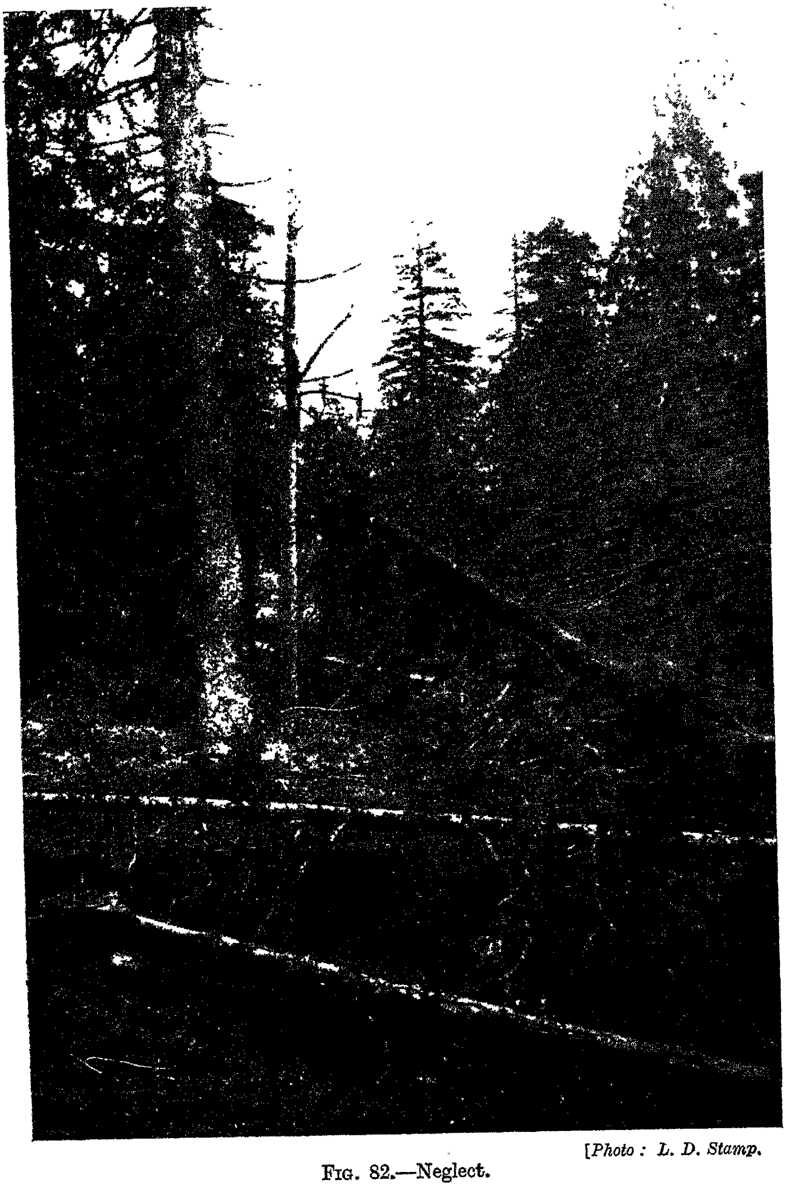


FIG. 81.—The proportion of forest land in the countries of Europe. In black, coniferous forest; stippled, hardwood forest.

in most of the European countries that it is with the utmost difficulty that an export of timber is being maintained, and it will become increasingly difficult for Britain to get her supplies from the chief exporting countries—Finland, Sweden, Poland, Norway, Czecho-slovakia, Austria and Rumania. There remains, of course, the greatest potential exporter, Russia. All the time there exists in the background the fact that Britain herself could supply, and should supply, a very considerable proportion of her requirements. There are vast areas of heathland and moorland and mountain side of practically little value which are capable of growing excellent forest, or at least forest of economic value, in an emergency.

The attention of the Government was focused on the timber resources of the British Isles during the Great War. Shipping which was really urgently required for the transport of food and

troops had to be utilised for the importation of that very bulky commodity—timber. There was ammunition to be made, for which



[*Photo : L. D. Stamp.*

FIG. 82.—Neglect.

View in a privately owned British forest, illustrating the neglect which sometimes characterises the woodlands of this country—which could, and should, produce the bulk of its timber requirements.

factories were required; they needed fuel and that fuel was provided by the coal mines. Coal cannot be mined without the extensive use of pit props. As early as 1916 the Reconstruction Committee set up a Forestry Sub-committee to consider ways and means whereby, in the event of another national emergency, an adequate supply of home-grown timber could be assured. The Sub-committee set before it the ideal that the British Isles should be self-supporting as regards timber throughout a period of at least three years. Amongst the recommendations of the Committee was that a Forestry Commission should be set up, and this Commission was actually appointed in 1919. The Forestry Commissioners calculated that it would be necessary to afforest 1,777,000 acres in order to provide for a national emergency lasting three years. Their scheme provided for the planting of this vast area in the course of 80 years, two-thirds of the programme to be completed within the first 40 years. In addition, the existing woodlands were to be rescued from the state of neglect into which they had long since drifted.

One of the first tasks undertaken by the Forestry Commissioners was a census of woodlands of Great Britain and a census of production of home-grown timber. The census was commenced on a trial basis in the autumn of 1921, but was not completed until the end of 1926; most of the work was done, however, during the year 1924. As a result of this census it was found that there were approximately 1,900,000 acres of woodland of all types, including scrub and devastated forest, in England and Wales and rather over a million acres in Scotland. The table given below shows the distribution of woodland by categories.

The classification adopted below has already been explained in Chapter VII, but something can now be added as to the distribution of these various types of timber. A map has been added showing the approximate distribution of woodlands in the British Isles, and it will be noticed that the most heavily wooded portion of England is that immediately south of London, including the counties of Sussex (with as much as 14 per cent.), Surrey (12·3), Kent (11·1), and Hampshire (11·6). In Scotland the most densely wooded part is the great Buchan plateau between the Moray Firth and the Firth of Tay, including the counties of Nairn (with 17 per cent.), Moray (16·3), Kincardine (12·6), and Aberdeen (10·1). In the north and west the proportion drops in Scotland to 0·4 in Caithness, and 2 per cent. in Sutherland. The other Scottish counties have more than 2 per cent.

Details were also collected as to the age of the trees in the forests, according to the age classes of 1–10 years, 11–21, 21–40, 41–80, and over 80. For all types of high forest, including coniferous, hardwood and mixed woods, the following results were obtained for Great Britain as a whole: 1–10 years 8·5 per cent.,

DISTRIBUTION OF WOODLANDS BY CATEGORIES, 1924

	England	Wales	Scotland	Great Britain	Percentage of total woodland area
	Acres.	Acres.	Acres.	Acres.	
I. Economic or Potentially Productive.					
High forest—					
Conifers . . .	195,231	46,940	429,670	671,841	—
Hardwoods . .	338,456	43,957	60,941	443,354	—
Mixed conifers and hardwoods . .	220,390	22,106	59,199	301,695	—
Total, high forest .	754,077	113,003	549,810	1,416,890	47·9
Coppice and coppice with standards .	485,229	35,331	8,120	528,680	17·9
Scrub	87,410	34,934	208,359	330,703	11·2
Felled or devastated	194,742	62,182	221,182	478,106	16·1
Total scrub and felled or devastated	282,152	97,116	429,541	808,809	27·3
II. Uneconomic (including amenity woods and shelter belts)	109,529	8,011	86,753	204,293	6·9
Grand Total . .	1,630,987	253,461	1,074,224	2,958,672	100·0
Total land area . .	32,037,243	5,098,762	19,069,728	56,205,733	—
Woodland area as percentage of land area	5·1	5·0	5·6	5·3	—

11–20 years 8·8 per cent., 21–40 years 18·1 per cent., 41–80 years 39·5 per cent., over 80 years 25·1 per cent. It must be understood that forest grown for timber has a definite rotation over a number of years. Thus a coniferous forest in Britain is reckoned to be fit for cutting over for timber about every 80 years, that is to say it has an 80-year rotation. Hardwoods, on the other hand, based especially on the oak, have a longer rotation, and forests can only be cut over for large timber every 150 years. Mixed forests are calculated on a 120-year rotation.[1] With regard to conifers it was found that the proportion of young plantations in the country was about right in relationship to the total area, and that there should therefore be forthcoming a small but steady supply of softwood timber. On the other hand, for the last 40 years there has obviously been very little planting of hardwoods. At the present rate of planting the

[1] These are approximate figures used in the Census Report. Actually, various rotations are employed when woodland is regularly managed.

supply must inevitably decline in due course to an absolutely insignificant quantity.[1] The table given above indicates the very large proportion, nearly half a million acres or 16 per cent. of the total area in 1924, which had been felled or devastated in the decade

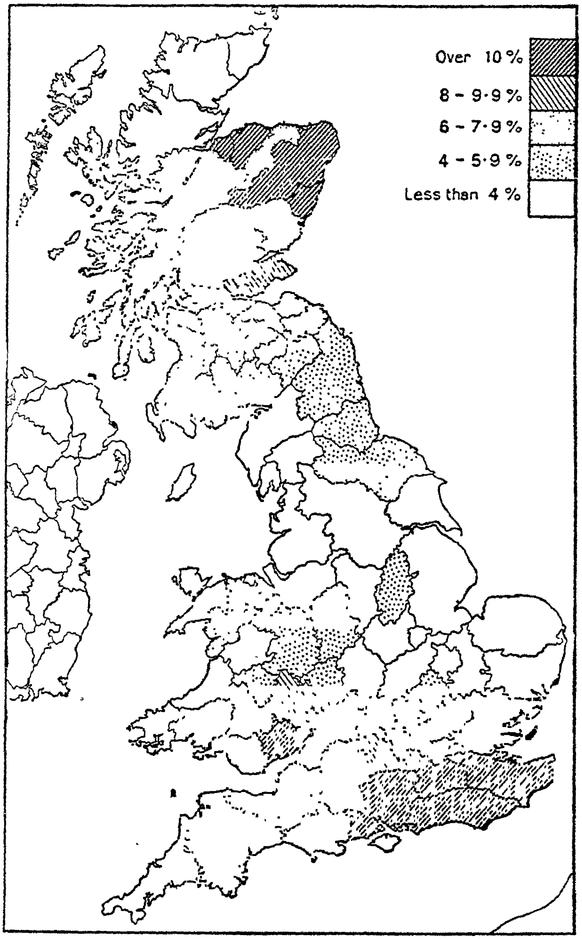


FIG. 83.—The wooded areas of Britain, according to the Census of Woodlands of 1924, showing the proportion of the surface of each county occupied by forest and woodland. The Isle of Wight should be shaded as part of Hampshire.

immediately preceding the census. This represents, of course, the extensive felling of forests which took place during the War, when the reserves of the country were very seriously depleted.

[1] Quoted from the Census Report. Mr. Ray Bourne points out, however, that many areas of oak coppice are now being allowed to develop as high forest.

Reference will be made below to new plantations for the replacement of this area, but the figures indicate very clearly the way in which hardwoods—mainly oak—have been displaced almost entirely by conifers.

Coppice, and coppice with standards, represent nearly 18 per cent. of the total area of woodlands. Of this approximately four-fifths is coppice with standards. Most of this area occurs in England, which has 91·8 per cent. of the whole area, compared with 6·7 per cent. in Wales and 1·5 per cent. in Scotland. Indeed, practically half of the woods of this description were found in the few counties of the south-east—Kent, Surrey, Sussex and Hampshire—where the coppice with standards is very largely the remnant of the former covering of damp oakwoods on the heavier soils in this part of England. Scrub represents a considerable proportion of the total woodland area. Sixty-three per cent. of the whole is found in Scotland, particularly in Argyll and Inverness. There it consists of sparse stands in birch, found over considerable areas of the Highlands. In the west of Wales a poor cover of dwarf oak is common. With regard to the felled or devastated areas it is estimated that four-fifths of the total were cut over during the War. In addition to this much forest which was cut over during the War has, of course, been replanted; and it is estimated that the amount cut during and immediately after the War comes in Great Britain to about 444,000 acres, and the volume of timber felled is estimated at approximately one thousand million cubic feet, or roughly one-third of the total volume standing in 1914. The census published an estimate of the contents of British woodlands as in 1924, giving the following results:

ESTIMATE OF CONTENTS OF BRITISH WOODLANDS, 1924

		Millions of cubic feet, quarter-girth measurement.
Saw Timber Sizes—		
Coniferous	748	1,546
Hardwood	798	
Pitwood Sizes—		
Coniferous	374	716
Hardwood	342	
Total		2,262

The estimate is for timber and pitwood sizes only and excludes branchwood; further, no account is taken of hedgerow timber or of contents of the 204,293 acres of woodland classified as uneconomic (amenity woods, etc.).

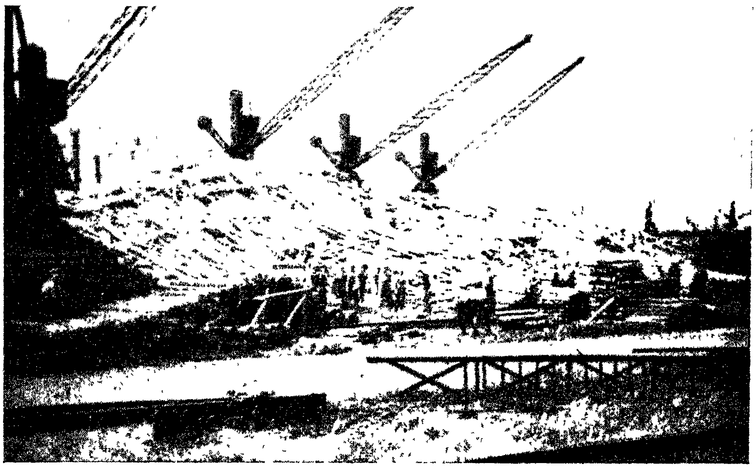
The average import of timber for the years 1924–28 (see E. C. Rhodes, *The U.K. Timber Trade Statistics*, London and Cambridge Economic Service Special Memoir, No. 30, 1929) was 10,000,000 tons of 50 cubic feet. Thus the total available in Britain in 1924 was only equivalent to 4½ years' supply. The imports in 1934–1936 averaged nearly 11,000,000 tons—at least ten times the home production. Home production in 1930 was 4·4 per cent. of total consumption, measured in terms of standing timber. Imports, 1937, 12,822,000 tons and 1,794,000 tons of pulp.

Amongst the points which come out particularly from the census are, in the first place, that there is distinct evidence that the total area of woodland is steadily decreasing, quite apart from the unprecedented cut during the War. In the second place, there is a great lack of young hardwood plantations. Oak planting, in particular, has gone out of fashion in favour of conifers, and when the existing mature and semi-mature oakwoods have disappeared, as they are steadily doing, the supply of home-grown oak will become negligible. In the third place, of the total woodland area of the country nearly 92 per cent. belongs to private individuals, 40,000 acres, or 1·4 per cent., to corporate bodies, and 199,000 acres, or 6·7 per cent., to the State. This represents the total area of State-owned forest, including plantable ground acquired by the Forestry Commission, up to September 30, 1924. The very large proportion in private ownership represents a factor of great difficulty in securing an improvement in woodland management or silviculture in this country. A visitor to this country from the Continent cannot help being struck by the neglected appearance of very many of our woodlands. The coppice woods of the south have the appearance of being worked, as indeed they are, but many of our forests and woodlands in private ownership are not touched from year to year, and no foresters are employed by the owners. This, of course, is not true of all, for many private woodlands are managed by trained men, such as land agents. The real trouble is the low demand for small material and the absence of a marketing organisation.

There is undoubtedly in Britain a remarkable apathy in matters relating to forestry and afforestation. It is true that the last few years have seen the resuscitation of an interest in forests and woodlands, and it is desirable to analyse the advantages and disadvantages of undertaking afforestation on a large scale. The following are the chief points which suggest themselves:

1. The climate of the British Isles is eminently suitable for the growth of forests and it should be remembered that the natural vegetation of the larger area is a forest of deciduous hardwoods, particularly oak, ash, and beech. The conifers, which have so largely attracted attention of recent years, are either naturally restricted to certain areas (for example, the Scots pine to certain areas of Scotland and to areas of sandy soil) or are exotic species introduced into the country and whose cultivation must still be regarded as in the experimental stage. In connection with these experiments there is need for comparative studies in all parts of the world and especially a detailed study of soil and other conditions throughout Britain. If one finds trees growing well in other parts of the world in a climate and with a soil that closely resembles their proposed home in the British Isles there is a reasonable possibility of success. The northern coniferous forests of

begin thinning—the cutting down of certain trees to provide increased room for selected ones. On this basis it is estimated that every 100 acres of forest will supply permanent employment for one man and his family until the first clear fellings are made when the trees are 60 or 80 years old. Actually, because of the large amount of afforestation work undertaken, the North-west Highlands of Scotland have shown that it requires about one man for every 50 acres. Nor does this represent the full total, for there will obviously be a demand for schools, for shops, for professional men, for transport workers supplying motor bus services, and so on, and a permanent rural population of some 50 to the square mile in afforested areas of the Highlands of Scotland is probably not a bad



[*Photo: S. H. Beaver.*

FIG. 84.—Unloading pit props at Newport Docks for use in the South Wales coalfield.

estimate. Unfortunately, afforestation is not an attractive pro position from the financial point of view to the private owner. As Mr. Claxton says in the article just quoted, "Forestry must be regarded in this country, as elsewhere, as a national duty rather than as an immediate source of revenue. The return on capital will probably not exceed 3 per cent. and this will not be realised until the forests are fully productive. On the other hand the position already expressed with regard to repopulation of such areas as the Highlands of Scotland is one of fundamental importance."

The total area of land acquired by the Forestry Commission to the 30th September, 1938, amounted to 977,381 acres, of which 622,781 acres were classed as plantable. In addition the Commission controls 120,000 acres of Crown woodland. Of the land

acquired, rather over half is in Scotland. To the same date 340,638 acres had been planted (conifers, 315,666 acres).

On the technical side, the question arises as to the areas which are still available for afforestation, particularly with regard to the upper limit of tree growth in this country. From observations carried out at the present day, it is found that there is very little forest of value grown above 1,500 feet in Scotland, and then only reaching such levels in comparatively sheltered positions. It is more or less generally agreed that the dominant westerly winds are the deterring factor in permitting forests to grow at higher levels. There seems, however, reason to believe that, with the gradual establishment of forests over large areas acting indeed as wind shelters to the interior portions of the forests themselves, this level can be raised to something like 2,000 feet. Thus the advantages of carrying out afforestation will be cumulative so far as the areas suitable for the purpose are concerned. The same is true of some of the higher areas in Ireland and the exposed situations in Wales and the Pennines in the north of England. The chief varieties of conifers planted in the wetter western Highlands of Scotland are the Norwegian spruce (*Picea excelsa*) and the Sitka spruce (*Picea sitkensis*). The Scots pine, the native forest-forming conifer of the British Isles, is more suitable for the drier central and eastern regions. The larch grows well but is rather liable to disease. There is a great hope that the Douglas fir, the most famous of all timbers from western Canada, will grow successfully.

It is desirable to mention here the work which is being carried out in afforestation by private owners. Grants of up to £2 per acre for conifers and up to £4 per acre for oak have been made by the Forestry Commissioners to private landowners and local authorities, but the number of applications for such grants is distinctly disappointing. Up to 30th September, 1930, 120,000 acres had been planted with the help of the Commissioners. In some parts of the country private landowners have led the way in forestry experiments in a remarkable fashion. As an example may be quoted the large tracts of different types of soil, including both the Wealden Clays and the sandy beds of the Greensand, which have been planted by Lord Cowdray on his estate in the western end of the Weald.

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CHAPTER X

AGRICULTURE[1]

Introductory

IT will be useful in the first place to try and appreciate the position which farming occupies at the present day in the British Isles. The farming population is, of course, essentially a rural one scattered over the whole of the face of the country. Regarding farming as one of the fundamental industries of the country, it is for that reason alone difficult to appreciate its importance relative to the other great industries of the country. Our mining population is concentrated essentially upon our coalfields. The employees and employers in some of our great manufacturing industries, such as the cotton or the woollen or the iron and steel industries, are again concentrated in relatively few areas. It is possible to study and evaluate the problems of such industries in a way in which it is difficult to do in the case of the farming industry. Farmers are diverse in their distribution, their difficulties, and their deserts. Perhaps it is true, therefore, to say that they are rather overlooked in a way in which their numbers and importance certainly do not justify.

If one takes as a standard of comparison the value of the produce of our main great groups of industries, it is possible to draw up a table as we have attempted below.

	England and Wales	Scotland	Northern Ireland	Eire
Agriculture (1924–5 to 1930–1) (value of produce sold off farms)	218	49 (1925)	11 (1928)	55 (1929–30)
Fisheries (1923–31)	14	4	0·06	0·4
Mines (1923–31)	206 (United Kingdom)			—
Manufactures (1924 Census)	3427 (Gross, Great Britain)		24 (net)	56

FIGURES IN MILLIONS OF £ STERLING

[1] The authors are greatly indebted to Sir John Russell, Director of the Rothamsted Experimental Station, Mr. G. V. Jacks, Deputy Director of the Soil Bureau, and Mr. H. V. Garner, Field Demonstrator at the Rothamsted Experimental Station, for numerous comments and criticisms on this chapter.

	England and Wales	Scotland	Northern Ireland	Eire
Agriculture (1930–1) .	197	49 (1925)	11 (1928)	55 (1929–30)
Fisheries (1931) . .	13	4	0·05	0·25
Mines (1931) . . .	167 (United Kingdom)			—
Manufactures (1930) .	2979 (Gross, Great Britain		20 (net)	57 (1929)

Population Employed in Agriculture

Great Britain . .	1911	1,429,000 or 7·79%	of the occupied population.		
	1921	1,307,000 ,, 6·75%	,,	,,	
	1931	1,194,000 ,, 5·67%	,,	,,	
Northern Ireland .	1926	147,500 ,, 15·3%	,,	,,	
Eire	1926	648,575 ,, 53·0%	,,	,,	

It will be seen that, quite apart from the large value of the produce consumed on the farms themselves, the value of produce sold off the farms exceeds the total value of the produce of all our mines, including our coal mines. In some parts of the British Isles, notably of course in Ireland, farming is overwhelmingly the most important occupation. If instead we take the numbers employed on the land then we find that Agriculture is the third largest employer in the country, and 1 in 10 or 1 in 12 of every man, woman and child in the British Isles is dependent upon the land for sustenance.[1]

There is a fundamental difference between the produce of British farming (*excluding Ireland*) and the produce of other great British industries. The produce of our farms is intended almost entirely for our home market, where it enters into competition with imported commodities. The produce of our fisheries, our mines and our manufactures, on the other hand, are for both home and foreign markets; the products of these industries enter into our export trade and abroad find competition from other countries. The farming industry is thus susceptible to protection or home control in a way in which the other major industries are not.

There is still another way in which the importance of farming to this country may be gauged. In addition to holdings of agricultural land of more than one acre in extent which are included in the annual returns made by farmers to the Ministry of Agriculture

[1] Agriculture still employs a larger number in the British Isles than it does in any of the great farming dominions of the Empire—Canada, Australia, South Africa, or New Zealand.

and Fisheries, there are allotments, small holdings, common land used for grazing, and so on, so that according to the census of 1925 something like 84 per cent. of the total land area of England and Wales may be described as land used for agricultural purposes. The corresponding percentage for the same year in Scotland, if one excludes the deer forests, is 73, the deer forests making up another 18 per cent. In Northern Ireland the corresponding figure is nearly 89 per cent. and in the Irish Free State 92 per cent. Yet any intelligent observer travelling about the British Isles must be impressed at the present time by the large proportion of agricultural land which is under-utilised. There are stretches of meadow ruined by thistles and other rank weeds through under-grazing, and it is very certain that, given suitable economic conditions, *the soil of the British Isles could be made to produce fifty per cent. more, possibly* 100 *per cent. more, than it does at the present time.* This alone affords an adequate reason for the detailed consideration of the present position.

A Sketch of the History of Farming in Britain[1]

We have already seen that the natural vegetation of the greater part of the British Isles is deciduous forest. It is clear that there were some areas where the forest was more open than in others, and perhaps more easily cleared, or it may even have been absent. The early settlers in the British Isles were naturally attracted to such tracts. There is clear evidence that it was the damp oak woodland of the lowlands which longest resisted attempts at clearing and cultivation. In many areas the distribution of Saxon place-names illustrates this quite clearly. The differing values of the various types of soil was, of course, recognised at a very early date. We have a permanent reminder of this fact at the present day in the curious shape of many rural parishes. For again and again parish boundaries are found to be so arranged that the parish encloses good land and poor, warm dry soils, and cold heavy soils[2] (see pp. 558, 559, and Figs. 85, 239). Quite apart from the different streams of culture which affected respectively the eastern and western coasts of the British Isles and which will be considered in a later chapter, there seems no doubt that the climatic contrasts between the eastern and western sides of the British Isles were responsible again at a very early date for the differentiation of distinct types of farming. In the east, with its greater suitability for arable farming, the nucleated village [3] from which farmers could reach the different types

[1] See especially Lord Ernle, *English Farming Past and Present*, 5th ed., edited by A. D. Hall, 1936.

[2] It is, of course, probable that the better lands were all settled first, and that the need for expansion involved settling or utilising tracts of poorer land.

[3] The site of the village was usually determined by an adequate water supply; in the damper country of the west water was available almost everywhere and made scattered settlement easy.

of land in the vicinity are characteristic, whereas in the west, with its greater suitability for pastoral farming, scattered farmsteads or tiny hamlets were the general rule and still tend to persist to the present day, notably, of course, in Ireland, where the village as understood in England is almost non-existent.

It was accordingly, especially in the southern and eastern districts of England, that the manorial system developed and became the controlling factor in medieval agricultural practice. The manor was the unit of land holding and cultivation, though there might be two or three manors within the limits of a parish (see p. 559). The lord of the manor held his land at one or more removes from the king; his tenants in turn held varying proportions of the land in return for various services which they had to render to the lord. The land could be divided broadly into three groups—the arable, the pasture, and the waste. The arable land was divided into three, or some multiple of three, open fields, which in turn were divided

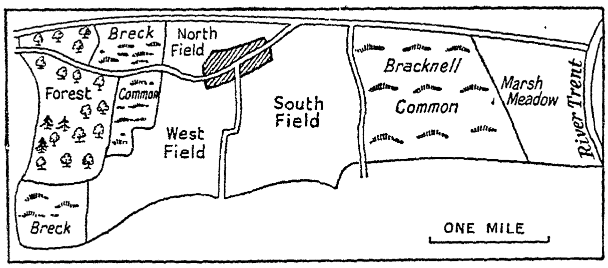

FIG. 85.—A Nottinghamshire parish prior to enclosure, showing the nucleated village, the three fields, the waterside meadows, the common or waste lands, and the woodland.

into strips of one acre or half an acre. The three fields corresponded with the fixed three-year rotation of a winter corn crop (wheat or rye), a spring corn crop (barley, oats, peas or beans, or mixed corn), and the third field bare fallow.[1] In each of the three large open fields the tenant held a certain number of scattered strips, the original intention being to give the tenant the benefit of variation in land, in good soils and bad. Intermingled were the strips that belonged to the lord of the manor himself and which constituted his demesne; each tenant was required to give a certain number of days' service in cultivating the strips belonging to the lord of the manor. In heavy land, such as is found over large tracts in the Midlands of England, the strips of cultivated land in the open field were steeply ridged to throw off surplus water, and this ridge and furrow is still found in many parts of the country, although this heavy land has long since been laid down to grass. This once

[1] Notice the simple requirements of the period—wheat or rye for bread; barley for beer; cattle, pigs, or sheep for meat.

ploughed land of the open field system with its marked ridge and furrow has been described by Mr. Punch, not inaptly, as the land of England which has been permanently waved. After the harvest the arable land was thrown open to cattle to wander over, the weeds and other vegetation providing them with a certain amount of food; but obviously this was a practice which prevented the growth of winter fodder crops. The meadowland was the lower land down by rivers and watercourses used for the production of hay and divided up in proportion with the arable land. After the hay harvest this land was usually thrown open to common pasturage. The hay harvest was known as lammas, and hence the name "lammas field" which is sometimes still used in country districts for pasturage by the side of streams. The third division of the manor, the waste land, was the origin of what to-day remains as small isolated tracts of common land or commons. On this the tenants had right of pasturage, and in suitable districts the right to cut turf or peat for fuel, and were also entitled to cut brushwood for burning, bracken for litter and reeds for the floors of their houses. From the common land also the tenants could obtain building stones, and other material, for the construction of their houses.[1] On the old manorial farms the level of production was exceedingly poor. Although about two bushels of wheat per acre were used as seed, the yield was commonly only about ten bushels per acre, or approximately five-fold. The yield from barley was little better, and of oats probably less. The conditions of livestock were probably even worse. The stock of all the tenants and of the lord of the manor were herded together and tended by the village cowherd, the shepherd, or the swineherd, as the case might be. Where there was much open downland suitable for pasturage for sheep, these animals naturally were most abundant. In predominantly wooded country the acorns provided an important food for the swine. In well-watered or reedy pastures cattle naturally took their place. Sheep were of value almost essentially for the sake of their wool, which formed an important commodity in English farming from very early times. The ewes were often milked, and the older animals killed for meat. During the open weather the sheep lived on the commons, in winter they were kept in folds, particularly on the

[1] Within 16 miles of London there is the manor of Ashtead, and a board standing on that manor in June, 1933, read as follows:

"All Persons who shall be found felling, cutting, digging, or taking or carrying away timber or other trees or pollards, turf, mould, gravel, clay, peat, sand, stone, furze, heather, or any other material (save and except the Person or Persons authorised by the Lord of the Manor or his Steward) will be prosecuted. Tenants or other persons requiring permission to take any of the above materials are to apply to the Lord of the Manor. . . . Horses, cattle, sheep, or any other animals found on the said common or waste lands and not belonging to Persons *having rights of Common*, the same will be seized and impounded."

Common rights survive in many other parts of the country, *e.g.* in Norfolk, and have considerable agricultural importance.

fallow, and fed on whatever rough pasture might be available. Cattle were kept very largely as agricultural animals. Ploughing by oxen was usual up to the seventeenth century, and did not entirely disappear even in England until the end of the nineteenth century. The cows were kept for milk, but the milk was usually converted into butter and cheese. In spring they were pastured on the commons or on the wetter pastures, already described, by the rivers, and in the latter part of the summer they were turned out on the stubble and fallow of the arable land. Food in the winter was a difficulty, and in the autumn a large number of the older animals were killed off and salted down for a supply of meat. But year after year there is little doubt that for the inhabitants of medieval England swine afforded the principal source of meat. It will be noticed that even at an early date the manorial farms supplied a considerable variety of produce. It was indeed the aim of the manor to be self-supporting both for food and clothing. Rarely was there any surplus of corn for sale, though money was received for the sale of livestock as well as for wool, skins, and a certain amount of dairy produce. The great variety of produce obtained from any one farm has remained an outstanding characteristic of British agriculture even to the present day and will be referred to again.

Quite apart from those areas of the country where the manorial system in its entirety was probably never practised, this strict system began early to break down. The lord of the manor would hence retain for his own use meadows and even arable fields. The tenants took to enclosing portions of the waste land and farming them for their own benefit, at the same time escaping the necessity of giving so many days' service to the lord of the manor by the payment of rent. The occurrence of a plague might deprive the lord of the manor of the greater part of his labour supply on the old system and necessitated the consolidation of holdings and their farming on a different basis.[1] Thus by Tudor times much land had already been enclosed, particularly perhaps in the south-eastern counties.

Towards the end of the sixteenth century, and in the early part of the seventeenth century, there was increasing trade and intercourse with the Continent, particularly with Flanders, and largely as a result of this new crops and stock came to be introduced into England, together with new methods of farming. Turnips and hops seem to have been introduced about this time, together with many of our common garden vegetables—such as cabbages, cauliflowers, carrots and parsnips, as well as a large number of fruit trees. Even more important was the introduction of clover,

[1] Particularly by putting the land down to grass, a single shepherd replacing a number of ploughmen. This occurred notably after the Black Death of 1349.

together with various fodder grasses. The importance of clover and other leguminous crops is two-fold, in that the bacteria which live in the tiny root-nodules of certain leguminous plants, including clover, have the power of absorbing nitrogen from the air and of converting it into nitrogenous compounds which can subsesequently be utilised by other plants as food. Thus these crops, instead of impoverishing the soil by taking from it nitrogenous plant foods, actually enrich the soil in these, though they remove others, especially potassium compounds. Further, clover and similar crops supply a winter food for stock, though it is obvious that under the old system when cattle were turned out on the arable fields after harvest that this would be impossible. Hence the improvement in agriculture which came at this period was only possible with the increase in the enclosures. By the beginning of the eighteenth century there had come into operation, instead of the three-year rotation or the three field system, what is now called the Norfolk or four-course rotation. In the first year wheat is grown, in the second year a root crop, particularly turnips. Then in the third year a second corn crop such as barley, and in the fourth year a leguminous crop, clover or beans, restoring the fertility of the soil prior to the growth in the next year of the crop of wheat in the next rotation. It was largely as the result of the introduction of the Norfolk system that England became an important corn exporting country, as it was during the first half of the eighteenth century until the growth of population and the development of industries absorbed all the food which the farmers could produce. At the same time the yield per acre increased greatly, and from what is known of conditions about 1735 that of wheat was probably about twenty bushels per acre, or at least double that of the medieval system. It has been pointed out that this improvement in agriculture would not have been possible under the open field system. From the time of Queen Anne onwards enclosure was legalised by means of private Acts. The apportionment during the course of enclosure between the lord of the manor and the tenants was usually fair; those who suffered were the small cottagers who had no arable land and therefore no title in the award and who found their common grazing land swept away with the commons. An additional hardship resulted because the larger landowners often took the opportunity afforded by the enclosure to put the land down to grass, so that a single shepherd would often take the place of ten or a dozen men who had formerly worked on the land when it was arable. Enclosure went on gradually all over the country until the General Enclosure Act of 1845. By that time such counties as Suffolk, Sussex, Kent, Essex, Somerset, Devon, and Cornwall, as well as the borders of Wales, had so far been enclosed that they were scarcely affected by the Act. Despite occasional hardships, which

it undoubtedly caused, enclosure was on the whole a measure of progress in British agriculture.[1] With it came the improvement in agricultural machinery which took place in the eighteenth century. Drainage, which had often been impossible under the open field system, was now widely extended, but it was not until later that drainage by land drains laid underground became general. It is interesting to notice that much of the progress of the period was due to the tenant farmers rather than to the landowners themselves. The tenants had the advantage in this respect—that they had not enormous sums of capital sunk in the land itself. Thus many of those who evolved the now famous English breeds of sheep, such as the Leicester, the Lincoln, and the Southdown, were tenant farmers; whilst among cattle, Shorthorn, Herefords, and Devon are great meat producers which have now found their way to all parts of the world. In fact, English breeds of sheep and cattle perfected during these times have now tenanted the greater part of the wool and meat producing regions of the whole world. Although much of this work was done by tenant farmers it was often the enthusiasm and the enterprise of the great landowners which created the necessary atmosphere of enterprise and confidence.

The Victorian era was a great period of scientific progress in British farming. The requirements of the different sown plants came to be scientifically studied, the use of artificial fertilisers began to spread. The first consignments of nitrate of soda arrived about 1830, and Peruvian guano about 1840. In 1843 Lawes, who is famous as the founder of the Experimental Station at Rothamsted in Hertfordshire, began the manufacture of super-phosphates at Deptford, and he quickly proved the value of ammonia salts (which could be made from by-products of the already very important gas-making industry) as fertilisers for farm crops. Foreign feeding stuffs, such as linseed cake and cotton cake, became general. The progress was so great that by 1870 the yield of bushels per acre had risen to thirty. After a terrible period of depression in the early part of the nineteenth century the position improved also as a result of the increasing demand for food from the growing industrial towns. This remarkable period of prosperity and development came to an end about 1874. High prices had been occasioned by the Franco-Prussian War of 1870–1871, but there followed a trade depression and a series of bad seasons. A new factor which has never ceased to operate from that time came into operation. It was the growth of railways and the development of steamship traffic which opened up international trade in agricultural products. Rapid settlement of new land in Canada and the United States and Australia followed, and supplies from new regions began to appear in quantity in the

[1] For it bound together grain production and cattle rearing—"More cattle, more manure; more manure, bigger crops; bigger crops, more cattle."

British markets. It must here be pointed out that many crops had been widely grown in the British Isles for which the climate of this country is not pre-eminently suited. One of the best examples is afforded by the cultivation of wheat in Ireland. The damp climate of Ireland with its frequent comparative absence of sun is not really suited to the ripening of grains such as wheat. Consequently, when improvements in overseas transport made possible the supply in large quantities of grain grown under climatic and soil conditions pre-eminently suitable (as in the Prairies of Canada), it became apparent that purely geographical conditions were asserting themselves. Here it may be well to state that the geographical factor in determining what crops can be economically cultivated has become in recent years more and more important. If only this were realised we should not attempt at the present day to encourage by protective duties, bounties and other artificial means the cultivation of crops which can be much more suitably produced in countries overseas where geographical conditions are more favourable. We should, on the other hand, study with greatest care the geographical conditions of this country, and so determine what crops may with greatest advantage be here produced in contrast to countries abroad where conditions for production are less suitable. Under this heading there naturally come such easily perishable commodities as soft fruit, which should be produced near the centres of consumption, and, of course, in the sphere of animal husbandry the production of fresh milk, which is a great advantage to have produced near at hand. We should tend to leave the production on an extensive scale of such commodities as wheat to overseas areas, since the climate of this country is not so immediately suitable.[1]

Other factors, of course, operated in the general fall in prices, and the great depression in British farming in the 'seventies of last century. The smaller farmers, especially tenant farmers, went bankrupt, and landowners found huge areas thrown on their hands which they were forced to operate on new large scale methods. There was naturally a considerable rural depopulation. There was a search for new crops which would solve the farmers' difficulties. Many important industries developed as a result, such as that of potato growing in the Fen country, and there followed the steadily increasing concentration on dairy farming. There was initiated an ever-increasing proportion of the land under permanent pasture, and a corresponding decrease in the area under the plough.[2] To some extent only was the abandonment of farming lands by crofters

[1] Though, of course, the conditions for wheat growing are excellent in the eastern counties.

[2] The seriousness of the position led gradually to more attention being paid to rural education, with excellent results. For a fascinating account of the history of the last century, see Sir E. J. Russell, *The Farm and the Nation*, London. Allen & Unwin, 1933.

in Scotland offset by the increased proportion of rough grazing, which was improved in parts of England, Wales, and Ireland. The general movement was interrupted in the latter part of the Great War, when the difficulty of obtaining the essential supplies of food grains and other foodstuffs from abroad resulted in the necessity of increased ploughing in the British Isles; but the cessation of the general movement was but a temporary one.

Trends in British Farming 1919 to 1938

The above short historical review brings us down to the war of 1914–1918, and we may now summarise the main trends in British farming in 1919–1938. The first is the steadily decreasing acreage under the plough, whether in England, Wales, Scotland, or Ireland. The details of this are given (pp. 153–155), both in the form of statistical tables and of graphs.

It will be seen that everywhere the position is roughly the same. In the main the cause is not far to seek. It has become uneconomic with the high cost of arable farming in this country to grow farm crops when there are readily available supplies from overseas countries where the conditions for their production are often more geographically and economically suitable. Undoubtedly the concentration in the future ought not to be on corn crops—such commodities which are usually stored and transported—but rather on such quickly perishable commodities as vegetables of most kinds, fruit, and crops which are required for feeding dairy cattle and poultry. The statistical tables show at the same time the general tendency for the area under permanent pasture to increase, and corresponding with this, the increase in the importance particularly of dairy farming, and the rearing of sheep, summer beef cattle and pigs. In the third place perhaps the figure of the greatest interest is that showing the movement of the total of crops plus grass. There is no doubt as to the increasing difficulty that Britain has of finding overseas markets for her exports of manufactured goods and coal. The resulting decreased ability to purchase foreign supplies of foodstuffs and raw materials ought to be offset by an increased and more intensive use of the land at home. To some extent this would seem to be the case. Here the diagram shows in the case of Northern Ireland, for example, the steadily decreasing proportion of the surface of the land which is not agriculturally utilised. In Scotland, however, the same is not the case. There a great deal of land once occupied by crofters has reverted to moorland or rough hill pasture and utilised probably as deer forest. In England and Wales there seems to be a tendency for land formerly agricultural to pass out of use. It seems almost inevitable that the near future must see a reversal of this process, a more intensive

Land Utilisation

England and Wales (Thousands of Acres)

	Arable land	Permanent grass	Rough grazing
1871–75	14,766	11,799	—
1876–80	14,348	12,802	—
1881–85	13,747	13,838	—
1886–90	13,243	14,560	—
1891–95	12,676	15,166	2,880
1896–1900	12,356	15,239	3,412
1901–05	11,914	15,545	3,614
1906–10	11,444	15,903	3,712
1911–15	11,131	16,013	3,786
1916–20	11,805	15,075	3,998
1921–25	11,144	14,805	4,873
1926	10,548	15,128	5,063
1927	10,310	15,280	5,126
1928	10,109	15,397	5,178
1929	9,948	15,490	5,178
1930	9,833	15,547	5,294
1931	9,582	15,701	5,316
1932	9,362	15,837	5,356
1933	9,250	15,870	5,398
1934	9,250	15,781	5,424
1935	9,398	15,559	5,420
1936	9,120	15,743	—
1937	9,024	15,757	5,442
1938	8,878	15,833	5,615

Scotland

	Arable land	Permanent grass	Mountain and heathland
1871–75	3,476	1,085	—
1876–80	3,542	1,148	—
1881–85	3,604	1,195	—
1886–90	3,668	1,208	—
1891–95	3,543	1,356	—
1896–1900	3,503	1,393	—
1901–05	3,463	1,428	—
1906–10	3,392	1,471	—
1911–15	3,312	1,494	—
1916–20	3,381	1,380	9,399
1921–25	3,297	1,422	9,642
1926	3,195	1,499	9,710
1927	3,169	1,513	9,897
1928	3,133	1,532	9,708
1929	3,105	1,548	9,573
1930	3,072	1,569	9,501
1931	3,052	1,580	9,497
1932	3,046	1,576	10,368 [1]
1933	3,030	1,584	10,441
1934	2,992	1,609	10,405
1935	2,983	1,616	10,383
1936	2,976	1,616	—
1937	2,992	1,579	10,481
1938	2,983	1,577	10,448

[1] Includes lands in deer-forests which can be used for grazing.

Eire (Thousands of Acres)

	Arable land [1]	Hay [2]	Pasture [3]	Other land
1847–56	3,338	1,047	7,933	4,525
1857–66	1,137	1,283	8,262	4,271
1867–76	2,649	1,474	8,789	4,062
1877–86	2,225	1,618	8,736	4,403
1887–96	1,982	1,747	8,736	4,520
1897–1906	1,754	1,787	8,969	4,486
1907–16	1,701	1,966	8,494	4,851
1917–26	1,862	2,144	7,975	4,940
1927	1,511	2,183	8,469	4,861
1928	1,529	2,155	8,432	4,908
1929	1,521	2,334	8,204	4,964
1930	1,458	2,296	8,082	5,188
1931	1,425	2,313	7,989	5,297
1932	1,424	2,282	7,957	5,362
1933	1,455	2,244	8,003	5,322
1934	1,497	2,147	8,053	5,328
1935	1,591	2,083	7,925	5,425
1936	1,621	2,050	7,936	5,418
1937	1,592	2,087	7,951	5,395
1938	1,568	2,037	8,040	5,380
1939	1,492	2,052	8,052	5,418 [4]

Northern Ireland (Thousands of Acres)

	Arable land [1]	Hay [2]	Pasture [3]	Grazed mountain	Other land
1847–56	1,064	193	1,383 [5]	711 [5]	
1857–66	1,098	254	1,354	646	
1867–76	995	324	1,430	603	
1877–86	880	352	1,451	668	
1897–1906	699	422	1,544	686	
1907–16	648	449	1,413	421 [5]	420 [5]
1917–26	669	465	1,391	522 [5]	305 [5]
1927	555	468	1,430	548	351
1928	566	448	1,432	557	348
1929	563	465	1,429	548	347
1930	535	478	—	—	—
1931	483	469	—	—	—
1932	490	453	—	—	—
1933	495	448	—	—	—
1934	495	443	1,528	526	360
1935	484	424	1,556	—	—
1936	472	416	1,584	—	—
1937	446	441	1,595	—	—

[1] Excluding sown grasses.
[2] From both sown and permanent grass.
[3] Temporary and permanent grass.
[4] Including 258,000 acres of woodland.
[5] Approximate.

utilisation of the land, whether it be the better land or poorer land. The better land could be more fully utilised by the substitution of market gardening for ordinary arable farming. Poorer land could be improved by attention being paid to its value as pasturage. That this can be done in the case of rough hill pasture has been shown by full experiments (see p. 193).

Characteristics of British Farming 1919 to 1938

In a broad sense British farming may be termed intensive as opposed to the extensive farming widely practised in newer lands, such as Canada, the United States, Australia, and South America. In other words, the British farmer cultivates "intensively" a comparatively small tract of land producing a variety of crops, whereas the extensive farmer, such as the wheat farmer, frequently devotes himself almost exclusively to the production of one crop and small quantities of subsidiary crops for his own use. Intensive farming involves manuring, and the practice of crop rotations is very usual. The second great characteristic of British farming results from this. It is that the British farmer, speaking generally, produces small quantities of a great variety of products—ground crops and animal products. We have already traced the rise of the Norfolk or the four field system in place of the old three field

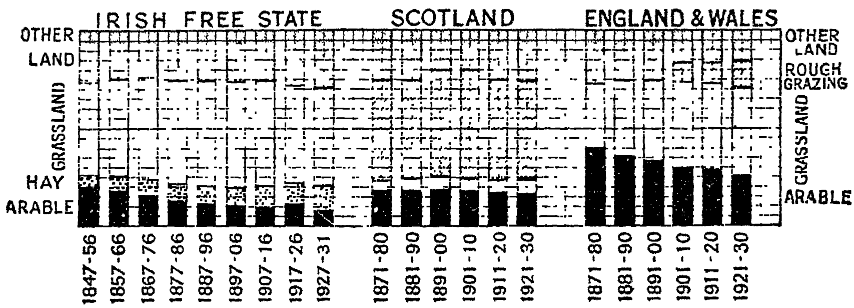

FIG. 86.—Diagrams illustrating the changes in utilisation of the land by decades in Eire (the Irish Free State), Scotland, and England and Wales.

system. It was during the scientific development in farming in the nineteenth century that this in turn gave place to a much greater freedom of cropping [1] with many varied rotations such as :

1st year	wheat
2nd year . . .	potatoes or other root crop
3rd year	oats or barley or beans
4th year	barley
5th year	clover or sown grass (*e.g.* rye) or leguminous crop.

A moment's reflection will show that the farmer who practises this system, however small his farm may be, will have at any one time in course of production at least five different crops. But let us consider these in turn. The wheat is probably intended for sale to the miller, for grinding into flour and so for human consumption. Of the root crops the potatoes may be intended for human consumption, but mangolds or turnips are more likely to be intended

[1] There is a marked tendency to break away from strict rotations. Longer lays are adopted in many areas, especially in the west where grass may be grown for 8 to 12 years and the land ploughed for one or two.

as winter feed for sheep and cattle. The oats may be consumed partly as fodder for horses working on the farms; it is unlikely that they are for human consumption, though some may be for feeding to stock, or for sale to corn chandlers. The barley again is not destined for direct human consumption, but for sale to maltsters for the manufacture of beer, or for feeding to pigs and other stock. Clover and grass are clearly not grown for human consumption, but for feed for stock, particularly cattle. Thus the farmer, in addition to being concerned with at least five different crops, is further concerned with horses, cattle, sheep, and probably also with pigs. Therein lies the crux of the farmers' great difficulty. It is the marketing of a great variety of varied products. He has the advantage of high yields per acre, he has the advantage of nearness of markets of consumption. His disadvantage is usually the absence of an effective marketing organisation. When commodities are imported into this country in large quantities they are distributed from the centres of import by efficient marketing arrangements, and the British farmer is usually in competition with these very efficient arrangements. Where the marketing of home produce is effective it is too often carried out by large combines who not infrequently tend to "squeeze" the farmer. The present marketing system is a result of gradual evolution, and has been described as an ever lengthening chain of middlemen. Generally speaking, agricultural produce in this country passes from the producer into the hands of the country dealer, then to the wholesaler, then to the retailer, and finally to the consumer. Not infrequently the greater the distance between the producer and consumer, the greater the number of middlemen. Additional links in the chain become apparent when some process is necessary, as in the curing of bacon in the bacon factory, and the canning of fruit in the fruit-canning factory. But the middlemen cannot be described as superfluous: they perform a number of definite functions. These functions may be grouped as follows:

(a) *Assembling.*—In general the production unit of the farm is small. The middlemen assemble larger numbers or larger quantities of agricultural produce, though it must be admitted in general that there are too many assembly units; for example, there are numerous small fat stock dealers who simply buy up stock in small markets and sell it again in large ones. For there are in England and Wales no less than 1,000 live stock markets.

(b) *Sorting and grading.*—In the past the middlemen have had much to do here, for quick judgment is necessary in the judging of agricultural produce which is often extraordinarily variable, and it is well known that the value of a whole consignment tends to approximate to the poorest which is included therein. The gradual development of the idea of standard grades replacing the old

individual judgment is affording a valuable lubricant to the marketing machinery, since it is possible to purchase without actually seeing the goods or the vendor. There are various methods of establishing standards, sometimes by producers or trades organisations, as in the case of jam, corn, and cheese; in other cases there are official standards set up by the State, especially in the case of agricultural produce intended for export, as with Irish poultry. Until recently standardisation in Great Britain was behind; but voluntary standardisation under the National Mark system was introduced by the Ministry of Agriculture in 1929, and now standards have been laid down for beef, eggs, canned goods, honey, etc. Thus National Mark eggs are now handled under London markets without the actual consignment being seen, merely on the grade name.

(*c*) *Packing.*—This is another function of the middleman, and one of the improvements desirable in Britain is the adoption of standard packages, instead of the great variety of shapes and sizes of packages which are now utilised. Middlemen, too, have been slow to adopt the non-returnable package.

(*d*) *Transportation.*—The large number of small middlemen existing in Britain results at the present time in a considerable degree of superfluous movement of agricultural produce; many eggs are sent from Cornwall to the Midlands, crossing on the way the stream of eggs from Lancashire to London, just as milk sent from West Wales to London crosses that sent from Hereford to South Wales.

(*e*) *Processing or Semi-manufacturing.*—Amongst the processes carried out by the middlemen may be mentioned canning, slaughtering, etc. Again, many of the units are far too small. For example, in the butchering trade there are 16,000 private slaughter-houses in England and Wales which average only 12 animals a week each, whereas the thousand public abattoirs average 600 animals per week, and in the small units there is a terrible waste of by-products.

(*f*) *Storage.*—This function of the middleman is necessitated because the producer usually lacks storage facilities and tends to glut the market and thus weaken his own selling position.

(*g*) *Financing.*—This is another function of the middleman, especially as there is usually a considerable lapse of time in agricultural industries between the expenditure, for example, of money for seed and the time for which money is received for the resulting produce, or from the time of outlay of capital on young stock and the receipt of money from butchers for the ultimate products.

It is clear that the problem of the middleman is a serious one, but perhaps even so the problem of distribution is still the major problem. There are 2½ million engaged in distribution in Great Britain, not of course all in foodstuffs. Whilst it is estimated that 25 per cent. of all retail trade is in the hands of the multiple shops and main stores, and a further 10 or 15 per cent. in the hands of

retail co-operative societies, there are still far too many small men, resulting in overlapping. For it must be remembered that distribution includes not only selling but to a considerable extent the determination of the retail price to the ultimate consumer, the adjusting or creation of demand by advertising, the preservation of the necessary balance between the processing firms and other buyers and the determination of the direction of markets. The process of integration into larger units which had tended to take place, especially in recent years, may be described as both horizontal and vertical throughout agricultural industries. As examples of horizontal integration it may be mentioned that the bacon factories of England and Wales are associated with one main group, the milling of both foreign and home-grown wheat is also in the hands of a few large groups, whilst the production of beet sugar is mainly in the hands of three groups. It will be noticed that this integration is particularly characteristic of modern developments, for example, the canning industry. As an example of vertical integration, the British and Argentine Meat Company handles the whole business from the steer on the Argentinian prairies to the retail shops in London and the provinces. It is held by many marketing experts, including Mr. A. W. Street, head of the Marketing Department of the Ministry of Agriculture, that all these integrations are to the good, but they have not solved the major problem—which is, that all supplies should be brought within a complete marketing policy. It is considered by this school that the quota system can be used for the orderly supply of a commodity to the markets, and that a quota system or restriction of imports must not be regarded for the purpose of establishing artificial high prices for home produce. For, whilst a country is not obliged to supply the full amount allowed under the quota, the prospect of a permanent reduction in the allotment would prevent a supplier sending any considerably smaller quantity. Thus it is held that the quota system might lead to a contractual system both for quantity and standard, thus giving a steady, even supply of agricultural commodities properly balanced with the home supplies. In the case of those agricultural products which are mainly of home origin the problem is not quite so complicated, and it might be thought that a co-operative organisation would give all the organisation necessary. Scarcely anyone in these days needs to be reminded of the results of co-operative organisation in marketing and its beneficial results in such cases as that of the Danish farmers and their bacon and butter industry; or of the Californian fruit growers with their oranges and other fruits; or of the South African farmers with their oranges and other fruits; or, again, of the New Zealand farmers with their butter. Co-operation has become firmly established in parts of the British Isles, the outstanding example being

the dairying industry of south-western Ireland, and certain trading corporations, such as the Eastern Counties Farmers' Co-operative Society, with its headquarters at Ipswich. But for the most part attempts at organising the sale of British farmers' produce on co-operative methods has been doomed to failure. The Agricultural Organisation Society found it necessary to dissolve in 1924. Co-operation has been encouraged by Government, as for example under the Agricultural Credits Act, which made provision for loans to agricultural co-operative societies on the basis of a loan of 20*s.* for every 20*s.* share taken up by a member. What are the reasons for this failure to organise on a co-operative basis? In the first place, co-operative selling means working to contract, and the production and regular delivery of the standardised article for the standardised price. But the British farmer is an individualist. This is at once his strength and his weakness. His markets are often near at hand, and there is the thrill of the auction when high prices *may* be realised—prices perhaps considerably in excess of a contract price previously arranged with a co-operative society. Thus co-operative bacon factories established in this country failed largely because they were not able to secure a regular supply of pigs—the farmers sending their pigs to market in the ordinary way when prices rose.[1] Actually in many cases the selling organisations which are quite independent of the producers are able to dictate the prices. This is to a considerable extent true with regard to milk. Unless the farmer establishes his own local milk round and sells his milk directly to the consumer he is gradually forced to accept prices determined by the milk distributing organisations. Much as one admires the individualism and the sterling independence of the British farmer, it must be admitted that co-operation seems to be the one path to salvation for the whole British farming industry. On the other side the farmers did not apparently obtain much benefit as purchasers when members of a co-operative society, simply because the suppliers of agricultural machinery and other requisites were so firmly established that they saw no reason to offer lower prices to the co-operative societies, purchasing in bulk, than to the individual farmers with whom they had long had dealings. A new position was created by the passing of the Agricultural Marketing Acts of 1931 and 1933, which give certain powers to the Ministry of Agriculture to organise co-operative marketing. Although still on a voluntary basis, in that each scheme must be approved by the majority of producers before it becomes binding, the State helps by organisation committees the establishment of a contract system, as in the case of milk and sugar beet, and so on. The marketing of hops was one of the first taken in hand, and was followed by pigs, milk, fat stock, and potatoes, and in Scotland by raspberries.

[1] Under the Regulation of October, 1933, bacon pigs can only be marketed by regular curers or through their agents.

Note on War Time Farming Economy

The outbreak of war in September, 1939, meant an immediate and drastic reduction of imports both of food for human consumption and feeding-stuffs for animals, and placed on the British farmer the task of greatly increasing home production. The plough-up campaign of 1939–40 aimed at adding 2,000,000 acres to the arable land (a 20 per cent. increase) and the 1940–41 campaign a similar total. Grass cannot be fed direct to human beings but cereals and root crops can, so that land under the plough is not only more productive but permits a greater flexibility in type of farming and farming produce.

The Peace Time Agricultural Output of the British Isles

We are now in a position to examine the relative values of the principal types of produce which are sold from off British farms. The table given below is based on the position before the depression. This table shows at a glance the relatively small value of farm crops. The value naturally tends to decrease with the decrease in the land under the plough. Even amongst these farm crops

THE AGRICULTURAL OUTPUT OF THE BRITISH ISLES
Value in Thousands of £ Sterling

	England and Wales 1924–5 to 1930–1	Scotland Census, 1925	Northern Ireland Census, 1925	Eire Census, 1925
I. FARM CROPS—	**45,066**	**9,200**	**2,859**	**7,649**
Corn	21,403	4,615	221	2,033
Potatoes	12,020	3,100	1,280	3,786
Sugar beet	3,626	—	—	259
Hops	2,647	—	—	—
Hay, straw, etc.	5,370	1,485	180	335
II. LIVE STOCK AND LIVE STOCK PRODUCTS	**149,516**	**38,660**	**11,824**	**50,555**
Live stock	74,293	26,430	5,490	26,975
Milk and dairy produce	56,266	8,900	2,919	13,693
Poultry and eggs	16,700	2,230	3,330	9,017
Wool	2,664	1,100	59	685
III. FRUIT, VEGETABLES, FLOWERS, ETC.	**23,536**	**800**	**390**	—
Fruit	7,677	400	56	466
Vegetables	9,301	240	279	—
Flowers	1,500	20	—	—
Glasshouse produce	4,877	120	55	—
Honey	180	20	—	16
Total	218,118	48,660	15,073	64,757
Total 1930	202,660	37,743	12,500	64,865

the high place taken by such specialised things as the recently introduced sugar beet is noteworthy, and it must be noted that a large proportion of the crops are intended for feeding to animals. The comparatively high figure for live stock on the other hand indicates the preference of the housewife for home-fattened and home-killed beef, mutton, and pork. The advantage of fresh home-killed meat is undeniable. In the case of pork and of veal it is difficult to obtain foreign substitutes, and hence in this branch of the live stock industry there is every reason for the British farmer to concentrate, more especially as his country produces the rich pasture grasses which are so eminently suitable for fattening. Moreover, the mildness of the climate permits cattle to be kept out of doors during most of the year. Greater attention ought to be paid to fattening foodstuffs, the use of which is still insufficiently understood in this country. The remarkably high place occupied by dairy produce is indicative of the tremendous advantages of a fresh daily supply of milk, sent almost direct from the producer to the consumer within the course of 24 hours. Yet the *per capita* consumption of milk in this country is still small as compared with certain other countries, and there is evidently room for expansion in this direction. The advantages of fresh milk may be compared with the advantages of fresh eggs, and it will be seen that eggs alone form an item of very great value. Despite the huge extension in recent years of poultry farming there is still a big import of poultry into this country, and there are great possibilities for further expansion in this direction. This will be mentioned later. The almost insignificant figure for wool is interesting when one compares this with the Middle Ages when wool was the staple product and export.

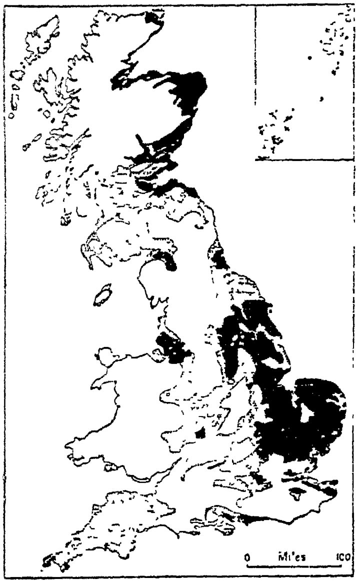

Fig. 87.—The chief arable areas of Great Britain.

Main areas in black; mixed arable and grassland dotted. In England it is easy to see that the chief factor concerned is climate. In Southern Scotland the same factor operates, but in the Highlands of Scotland it may be said that if the land is worth "improving" from the main mass of moorland it is ploughed rather than put down to permanent grass.

The Spacial Distribution of Crops in the British Isles

In a previous chapter we have said something about the distribution of moorland and rough hill pastures in the British Isles. If we now take the bulk of the remainder of land used for agricultural purposes, it can be divided into arable or tilled land on the one hand and permanent grassland on the other. Two maps have been prepared: one shows the counties of the British Isles where the

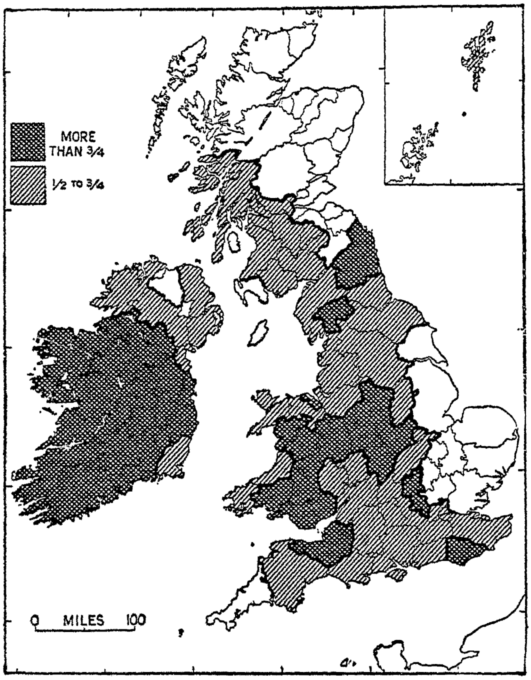

FIG. 88.— Permanent grass in the British Isles.

Each county shaded has more land under permanent grass than under the plough. In the darkly shaded area the acreage under grass is at least three times that under the plough. In the one unshaded Irish county there is almost an equality. Notice the factors favouring permanent grass: low ground and good rainfall.

area under the plough exceeds the area under permanent grass, whereas the other shows the area where land under permanent grass exceeds the area under arable land. In view of the rapidly changing relationship in this respect it has been deemed advisable to draw these maps from statistics of the latest year available, and they consequently apply to the year 1931. These two maps show at a glance that the counties where arable farming predominates over grassland farming or stock rearing are exclusively in the drier east of the country. We shall accordingly expect to find

a concentration of all the main crops on the eastern side of the British Isles, and we will now proceed to examine the present distribution of the leading crops and attempt to evaluate the factors which are determining that distribution. Before doing so it will be useful to give a table showing the acreages under the principal crops at the present time in the British Isles.

ACREAGE, YIELD PER ACRE AND TOTAL PRODUCE OF THE PRINCIPAL CROPS IN THE BRITISH ISLES, 1921–30

Crop	Acreage (thousands)	Yield per Acre		Total Produce (tons)
		Bushels	Cwt.	
Wheat	1,696	32·3	17·9	1,517,000
Barley	1,507	33·6	16·0	1,202,000
Oats	3,894	43·3	15·3	2,975,000
Potatoes	1,175	—	Tons 6·1	7,214,000
Turnips and Swedes	1,410	—	„ 14·2	20,083,000
Mangold	430	—	„ 18·8	8,108,000
Hay	9,319	—	„ 1·38	12,868,000

Wheat.—The acreage under wheat in the whole of the British Isles in the year 1931 was 1,271,000 acres, the lowest total ever recorded.[1] Of this area 1,197,000 acres were in England and Wales, leaving only 50,000 acres in Scotland and 25,000 acres in Ireland. The total production in the same year was 950,000 tons in England, 12,000 tons in Wales, 48,000 tons in Scotland, 24,000 tons in Ireland, making a total for the whole of the British Isles of about 1,034,000 tons, compared with an import in the same year of roughly 5,968,000 tons. Two maps have been prepared to show the geographical distribution of wheat in the British Isles at the present day. The two maps afford a contrast in method but teach precisely the same lesson. In the first, Fig. 89, each dot represents 500 acres of wheat in the year 1931. It illustrates the remarkable concentration of wheat cultivation in the East Anglian counties which have the combined advantages of a low rainfall, a comparatively high summer temperature and a good amount of sunshine, and large tracts of undulating or level land suitable for ploughing and with fertile mixed soils. In Scotland it will be noticed that the small amount of wheat cultivation is restricted mainly to the south of the country and to its eastern margin; where again the advantages of a comparatively low rainfall—less than 30 inches—are enjoyed. The northernmost extension of wheat cultivation is actually on the good red soils of the Old Red Sandstone around Moray Firth. It is, however, broadly correct to state that in the British Isles the 60-degree isotherm for the month of July roughly marks the northern limit of *extensive* wheat cultivation.

[1] Following the abandonment of Free Trade by the National Government in 1932 and the introduction of a "Wheat Quota," acreage rose in the United Kingdom to 1,928,000 in 1938 (England and Wales 1,830,000; Scotland 92,000). Acreage in Eire jumped to 94,000 in 1934 and 163,500 in 1935.

Just to the south of this line lie the Vale of York and Holderness. Wheat grown under conditions of too much moisture is difficult to harvest because of liability to disease. The present distribution of wheat cultivation in the British Isles raises the conception of two different types of limit. Broadly speaking, it may be said that the possible limits of cultivation of any crop are determined by geographical, primarily by climatic, conditions. The limits so deter-

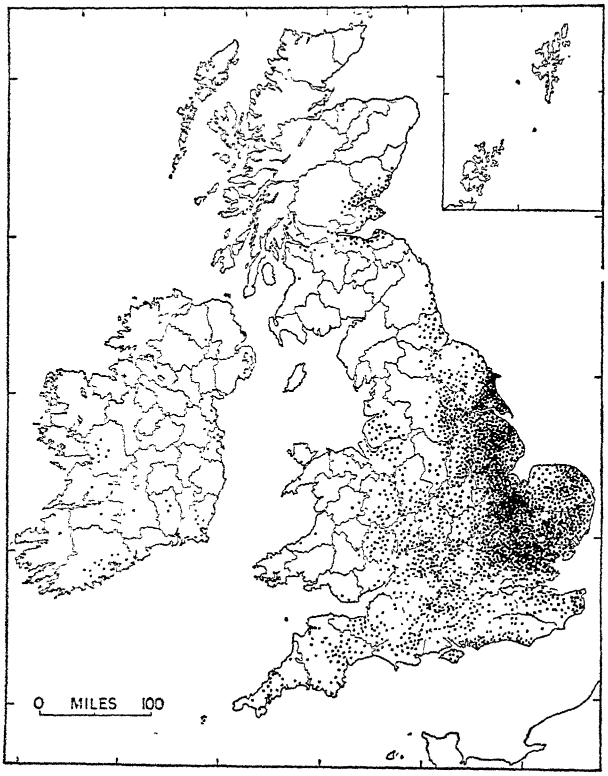

FIG. 89.—Map showing the distribution of wheat cultivation in the British Isles. Each dot represents 500 acres in 1931.

mined may be described as the ultimate or the geographical limits. As far as wheat is concerned it may perhaps be said that this limit is almost reached in the north of Scotland, and that the Plain of Caithness, the Orkney and Shetland Islands lie outside the limit; but the whole of Ireland, Wales and England, and the southern two-thirds of Scotland are definitely within the limits so defined. But it is found in the case of any crop that as one approaches the ultimate limits possible for cultivation there is usually a belt where

natural conditions are far from the optimum required, and where crops are likely to be poor or uncertain and yield or quality poor. Thus there is a second inner limit of cultivation which may be described as the limit of large scale cultivation or perhaps as the economic limit of cultivation. Within this limit natural conditions are sufficiently suitable *ceteris paribus* to give the crop concerned a reasonable chance of competition with other parts of the world. In broad terms the economic limit for wheat is reached and passed in the British Isles, since it may be said to correspond roughly with the 30-inch rainfall line on the west, and roughly with the 60-degree July isotherm on the north, bearing in mind that there are certain specially favoured patches of land further north which may be regarded as islands or outliers having the suitable conditions. On this basis the southern and eastern counties of England and the

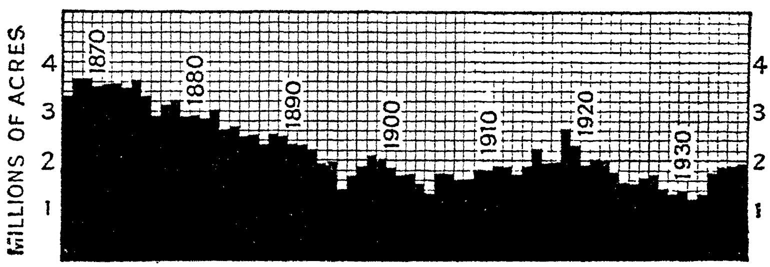

FIG. 90.—The decline in acreage under wheat in England and Wales.

Midlands are the only areas where wheat cultivation should be encouraged. The whole of Ireland is excluded, the whole of Wales, much of western England, and the greater part of Scotland. Actually in past years when competition from foreign grown wheat was much less important than at present, or almost absent, the grain was grown in large quantities over the fringing tracts outside what are now the economic limits. But conditions in that outer fringe were certainly never near the optimum necessary for the crop. This is extremely important, because it is frequently urged that the decline in wheat cultivation in such areas as Ireland is due primarily to economic and historical causes. The truth would seem to be that Ireland, like many another country, was producing a crop for which the country was not climatically suited. Detailed agricultural statistics have been collected in Ireland since 1847, in Scotland since 1871, in England and Wales since 1867. The total given below shows the maximum acreages recorded under wheat.

England and Wales	3,404,000 acres—1871–75
Scotland	135,700 acres—1872
Northern Ireland	89,403 acres—1858
Eire	671,448 acres—1847

Broadly speaking, in each part of the British Isles there has been a general decline from these early high figures. The general decline has been hastened or interrupted by economic crises, such as the heavy drop in the 'seventies of last century, already mentioned, and the temporary rise during the Great War. Despite the enormous differences between the former and present acreages under wheat in western and northern areas there is a point which ought not to be overlooked. In Ireland wheat has never been a crop of primary importance. In what corresponds to Northern Ireland, even at the time of its maximum extension in 1858, it only occupied 8 per cent. of the ploughed area, in what now corresponds to Eire (the Free State) its percentage was even less. Compare this with the fact that even as late as 1925 wheat occupied 28 per cent. of the total arable area in the English counties of Huntingdon and the Isle of Ely, where conditions approach as near as possible to the optimum in this country. These figures naturally suggest another way of expressing the distribution of wheat cultivation, a method which was used in the maps illustrating the Agricultural Output of England and Wales in 1925. The map here reproduced, Fig. 91, shows the *percentage* of the arable land in each county of England and Wales which was devoted to wheat cultivation in 1925. It illustrates that the focus of cultivation is the flat land round the Wash; radiating from this centre the proportion of wheat becomes gradually smaller and smaller, until in the extreme north-west of England and Wales, or the extreme south-west, the proportion is less than 5 per cent. In 1925 the proportion of arable land occupied by wheat over the whole of England and Wales was 14 per cent. On the other hand, in Northern Ireland (1929) it was only 0·6 per cent.

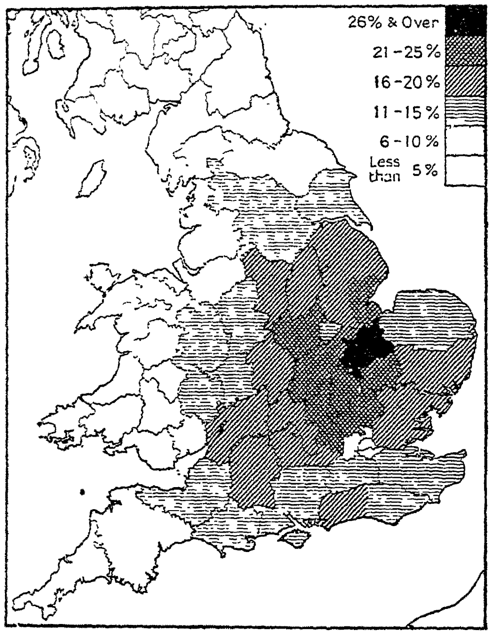

FIG. 91.—Map showing the percentage of arable land in each county devoted to wheat (Census of 1925).

Two features of wheat cultivation in the British Isles remain to be mentioned. The first is the high quality of the wheat. It is in general a soft wheat excellent for biscuits and for poultry,[1] and for blending with harder foreign wheats. The bulk is winter sown. The other feature is the remarkably high yield per acre. For the ten years 1921–30 the yield in England and Wales averaged 17·7 cwt. (32·0 bushels) per acre, the weight averaging 61·9 lbs. per

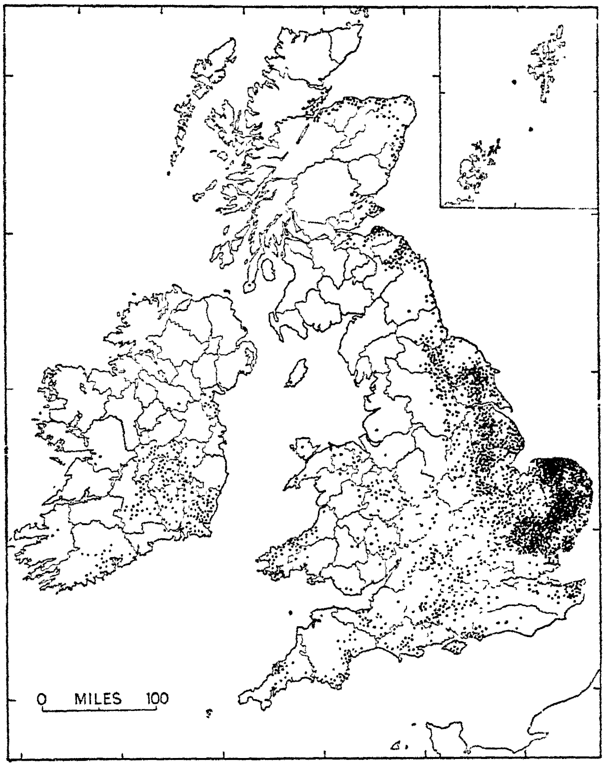

FIG. 92.—Map showing the distribution of barley cultivation in the British Isles. Each dot represents 500 acres in 1931 (Ireland, 1930).

bushel. It is interesting that near the limit of wheat cultivation where the crop can be grown in favoured localities the yields are often extraordinarily high. In Scotland, in the census year 1925, it reached 22·4 cwt. or 40·5 bushels per acre. In Northern Ireland the highest ever recorded was 21·0 cwt. in 1929.

Barley.—Thriving on lighter poorer soils, the conditions for the cultivation of barley resemble generally those for wheat. There

[1] But not by itself for bread; few British housewives would buy all-British bread; people praise it, but do not eat it.

are two main points of difference. Barley is even less tolerant of excessive moisture than wheat and tends to be still more restricted to the drier sides of the islands of Great Britain and Ireland. This is beautifully shown in the case of Ireland where barley cultivation is virtually restricted to the south-eastern corner of the uplands of Wexford, and in the sheltered valleys further in the interior, or in the small patch of comparatively dry land round Dundalk further north. Similarly in Scotland it is essentially along the eastern coastal fringe that barley can be cultivated. In England and Wales there is once more a concentration of the crop in the counties of eastern England. On the other hand, barley has a greater northern extension than wheat. This may be partly due to the fact that barley can take advantage of the longer days of sunlight in the summer and so will ripen while wheat will not.[1] Those who have travelled in northern Finland or Sweden or Russia will have become familiar with the crops of barley ripening possibly a hundred or more miles within the Arctic Circle. Thus the northern limit of barley cultivation, given sufficiently dry conditions, is not reached in the British Isles. Barley is not grown primarily as a human foodstuff: about half is malting barley and is taken by the maltsters and the breweries. All kinds of beer, to which reference will be made below, have barley as their basis; whilst in Scotland the distillation of whisky from barley is, of course, an important industry. As the table given on p. 163 shows, the yields per acre of barley are again good as in the case of wheat. Considering the percentages of arable area in different counties occupied by barley, it is found that the highest figures are reached in Norfolk, which in 1925, according to the census, had over 26 per cent. of its arable acreage under barley, and Rutland with 29 per cent.

Oats.—Oats are much more widely grown in the British Isles than either wheat or barley. Actually the *optimum* conditions for oat cultivation closely resemble those for wheat, but oats *will* grow and ripen under conditions of much greater dampness, and hence of all the grain crops it is the one most eminently suited for the climatic conditions of Ireland, the west of England, Wales, and Scotland.[2] If one studies a map showing the distribution of acreage under oats in the British Isles one notices again a concentration on the eastern dry sides of both islands, especially for example in East Anglia; but here oats are in direct competition with

[1] But in this country barley is spring sown and wheat is winter sown; therefore it is only where the winter is mild that the wheat will survive. Spring wheats give too low a yield (20 to 25 bushels per acre) to be economical in this country where winter wheats yield 30 to 40 bushels. So far attempts to find a good winter-sown barley have not been successful.

[2] Winter-sown oats are usual in the north, spring sown in the south. One reason why oat crops tolerate more moisture than wheat or barley is that the crop is cut before it is dead ripe and there is no need to wait as long at harvest time before cutting as is necessary for wheat and especially for barley.

both wheat and barley, and so if one takes the proportion of arable land in each of the counties occupied by oats one finds that this crop is grown least in proportion to the total arable area in the eastern counties from Lincolnshire southwards, and most in proportion to the total arable acreage in western counties. Thus over 30 per cent. of the total arable area in Cumberland, Westmorland, Lancashire, and Cheshire was, according to the census of

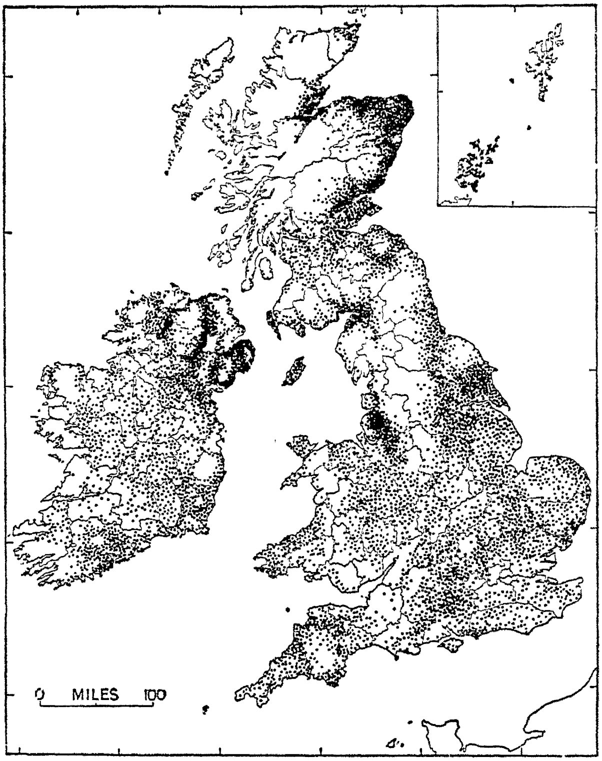

FIG. 93.—Map showing the distribution of oat cultivation in the British Isles. Each dot represents 500 acres in 1931 (Ireland, 1930).

1925, occupied by oats. In most of the Welsh counties the proportion ranges between 25 and 30 per cent. In Scotland oats occupy at the present day more than 50 per cent. of the total tillage area; thus this cereal plays a far greater relative part in the agricultural economy of Scotland than it does in either England or Wales. Indeed, the map of the distribution of oats in Scotland is almost a map of the distribution of human settlements. Similarly of all grains, oats are best suited to the climatic conditions prevalent

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in Ireland. Under the bright sunny conditions favoured by barley, oats do not flourish and so, for example, are scarcely grown at all in the Mediterranean countries of Europe. It is a very interesting commentary on the climatic conditions of Ireland that no area is too sunny or too dry. Indeed, the area of greatest cultivation is in the south-east—an area where, as in East Anglia, there is competition with barley and wheat. Oats occupy roughly 45 per cent. of all the land devoted to crops, excluding hay, in Eire. This proportion relates to 1930, but it differs but slightly from that when statistics were first collected in the period 1847–56. A map showing the distribution of oats in Ireland does not correspond quite so closely to a population map as in Scotland, owing to the extensive use of potatoes as human food in Ireland. The purposes for which oats are grown are interesting. In the case of Eire the position is as follows:

Fed to live stock, especially on farms	70 per cent.
Used as seed	11 ,,
Sold by farmers and consumed in Eire	12 ,,
Exported	7 ,,

Of that sold by farmers a large proportion is fed to non-agricultural horses. In Scotland it has been estimated that rather more than half the total crop of oats is used for horse fodder and for seed; but a large proportion of the remainder is destined for human consumption. Although amongst town dwellers their popularity in recent years has declined, both porridge and oat-cakes are characteristic articles of diet in Scottish homes. The fine physique of the Scottish highlanders has been attributed—probably with some measure of correctness—to the nutritious value of oats as a food. In England and Wales oats are grown mainly for feeding to live stock [1] and especially to horses, only a very small proportion is intended for human consumption and that mainly in the form of patent foods such as the well known "groats." It should be noticed that oat straw is of great value as animal food, being better for this purpose than the straw from either wheat or barley; thus in Scotland the average weight of oat straw produced is something like $1\frac{1}{2}$ million tons. The straw is less abundant than in the case of wheat.

Rye.—Rye is often referred to as the poor relation of wheat. It flourishes under similar conditions but will grow on far poorer soil. It is thus widely grown on the glacial soils of the North European Plain, which are the counterpart of those found in such tracts as central Ireland, and much of Scotland. But except as seed to produce green crops for sheep feed there is little market in Britain

[1] With existing low prices of cereals a larger and larger proportion of all cereals tends to be fed to stock on the farms, the grain grown thus being "marketed" as animal products for which better prices can be obtained.

for rye and the acreage is extremely small. In medieval Britain rye was quite an important grain, but the British people have lost, if they ever had it, the taste for the rather sour though nutritious rye bread so often referred to in this country as "black bread," and which is familiar to all visitors to Germany and to eastern Europe. The crop occupies 3,000 or 4,000 acres in Ireland, about 5,000 acres in Scotland, and some 50,000 acres, according to the census of 1925, in England and Wales. A considerable proportion, probably more than a quarter, is cut green as fodder, and the remainder is allowed to ripen. Some of the home-grown rye is used in the distillation of rye whisky.

Beans and Peas.—Beans and peas, when allowed to ripen, are included as corn crops, but of the total acreage in England and Wales something like a third or more of the peas are intended for picking green, and about 6 per cent. of the acreage under beans for the same purpose. Considerable quantities are also used green for fodder. The distribution of beans and peas is interesting. They were once an important crop in Ireland and occupied over 25,000 acres in the period 1847–56 in what is now Eire and another 12,000 acres in what is now Northern Ireland. They have become almost extinct as an agricultural crop in the Free State and occupy but a very small acreage in Northern Ireland. The same is very largely true in Scotland. A hundred years ago the area under beans in Scotland was estimated to be over 100,000 acres. In 1929 it was less than 3,000, and that was mainly in one area—the Carse of Stirling. Although they only occupy together about 3 per cent. of the arable land of England and Wales, the total acreage is considerable. In 1931 the total acreage under beans was 158,000 acres, of which 145,000 were harvested as corn; in 1931, 132,000 acres were under peas, and there is a marked tendency for a decrease in the area harvested as corn and an increase in the area picked green, especially for canning.[1] Reference will be made to this in a later section.

Mixed Corn.—The growing of mixed corn crops is of comparatively little importance in the British Isles except in a few counties, such as Cornwall, where barley and oats (dredge) are grown together and provide fodder for live stock and can be cut green if necessary.

Potatoes.—The distribution of potato cultivation in the British Isles affords the most interesting example of the interaction of geographic and economic factors. In the first place, potatoes are grown for food, either for animals or for human beings. There is not that important production for purposes of distillation of industrial alcohol that one finds on the Continent of Europe, particularly in Germany. On the other hand, potatoes play entirely different rôles in the agricultural economy of Ireland on the one

[1] In 1932 the total for peas was 126,700 acres; for beans 153,400 acres.

hand, and of the greater part of England, Wales, and Scotland on the other. Taking first the position in Ireland, we may with advantage quote statements which were made in the Agricultural Atlas of Ireland,[1] "the peculiar suitability of potatoes to the humid soil and atmospheric conditions of Ireland was by no means appreciated a century ago, when oats, wheat, and barley were the staples. It is not too much to say that the increased cultivation

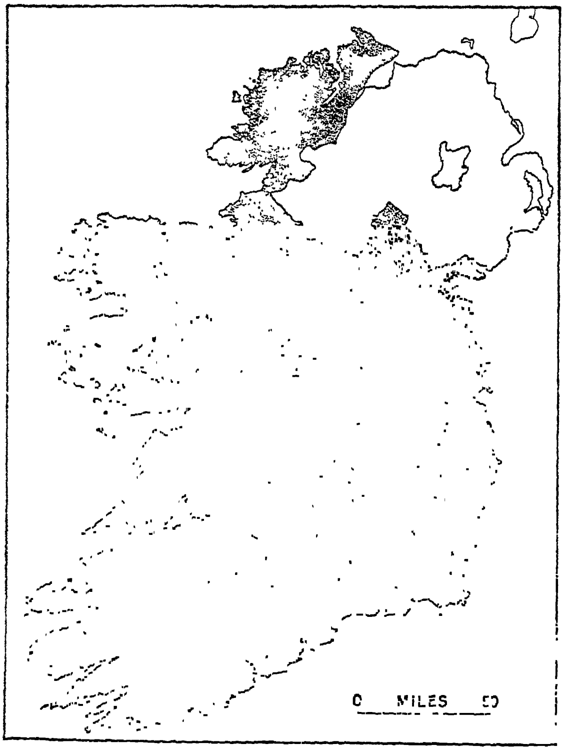


FIG. 94.—Map showing the distribution of potato cultivation in Eire. Each dot represents 25 acres in 1929. (*From An Agricultural Atlas of Ireland, by permission of Geo. Gill & Sons, Ltd.*)

of potatoes rendered possible an increase of population, and perhaps actually occasioned the over population of rural districts prior to the terrible famines of the 'forties of last century." The acreage and production actually reached a maximum in 1859 when in the area which is now known as Eire there were 923,054 acres under potatoes. Whilst in common with all other crops there has since been a steady decline in acreage and production, the fall has not

[1] *An Agricultural Atlas of Ireland*, by L. D. Stamp. Geo. Gill & Sons, 1929.

been as rapid as in the case of oats and of most other crops. Indeed, the relative proportion of potatoes has risen. In the decade 1847–56 potatoes occupied 19 per cent. of the land devoted to crops; in 1930 the percentage had risen to nearly 24. The annual production of potatoes in Eire now averages over 2,000,000 tons—equivalent to about 14 cwt. per head of population. Taking the census year of 1926 it was estimated that this huge production was used as follows:

Food for stock on the farms	47 per cent.
Kept as seed	15 ,,
Consumed by the people	37 ,,
Exported	1 ,,

It will be seen that the people of Eire "eat" or consume about a quarter of a ton of potatoes per head per year. The townsfolk consume only about 1·7 cwt. compared with 7 cwt. for the country-folk. The explanation of this difference is that large quantities are prepared and cooked in country households but only a proportion actually eaten, the rest being fed to pigs and other live stock. The map of the distribution of potato cultivation in Ireland shows that this crop is practically ubiquitous. The blank areas on such a distribution map are either mountains or wide stretches of bogland. It is difficult to separate areas particularly favourable for the growth of this crop, but there are four types of land which seem to demand special mention:

(*a*) Wide stretches of ill-drained land in the Central Plain where few other crops are possible.

(*b*) The lowlands of the west, especially in County Kerry and County Clare, where there is not only a heavy rainfall but a large percentage of damp misty days and a large proportion of days on which these lands are swept by strong winds from the Atlantic—factors which combine to render the cultivation of cereals difficult.

(*c*) The more favoured lowlands of central Galway and Mayo, whilst having an important production of oats, also favour potatoes.

(*d*) The gently rolling lands which form a continuation of the Southern Uplands of Scotland also have very large areas under potatoes.

Similarly, in Northern Ireland, where potatoes occupied in 1932 142,000 acres—or considerably below the average for recent years—the crop is very widely distributed on all the lower lands. Turning now to Scotland, as a food crop to supply local needs, potatoes are grown all over the country, but they play an especially important part in the Shetlands, the Western Isles and in the Highlands as a whole. They are grown irrespective of favourable soil or climate, and thus in these parts of Scotland—the more remote areas—potatoes occupy a position similar to that which they do in Ireland. On an acreage of between 140,000 and 150,000 acres the average yield is 6·7 tons per acre, so that the normal total approaches a million tons. Apart from the wide distribution over the Highlands

just described, there are certain areas in Scotland where potatoes are grown as a main crop or where special attention is given to the raising of potatoes as an early crop. The eastern parts of the Central Lowlands are particularly favourable—especially on the rich deep loams. The main areas for the production of early potatoes in Scotland are situated to the south-west, that is on the side of the country which is the warmer in winter, and of special importance is Ayrshire. Close proximity to the sea permits sowing as early as February and the crop is lifted, largely by Irish labour imported temporarily for the purpose, towards the end of June or early in July. Here the soil is light and sandy and has to be enriched by heavy manuring. Markets for these early potatoes of Ayrshire and for the main later crop of the eastern part of the Central Lowlands are, of course, near at hand in the densely populated parts of the Central Lowlands, but there is still a surplus available for sending southwards to England. Both from the point of view of the character of the crop itself and from the relatively low value per bulk, potatoes enter but little into international trade. Whereas in the British Isles as a whole, the larger proportion of the wheat which is required is imported, the potatoes consumed in Britain are in the main home produce. Imports are small and consist mainly of new potatoes sold at high prices before the earlier varieties of home-grown potatoes are ready. As a crop grown for sale potatoes are rather speculative owing to the variable yield and the inelastic demand, so that a small excess gluts the market. In England and Wales again potatoes are widely grown for local consumption, but in this case they do not occupy more than 5 per cent. of the total land under the plough in the counties concerned. What one does notice in the case of England is the very remarkable concentration of potato cultivation in two or three areas. Where potatoes are grown for sale to the densely populated areas two factors are paramount. The first is the suitability of soil—deep, rich, loamy soil being the best—and especially one free from stones which interfere with the free growth of the tubers. Secondly, there must be the ready accessibility to adequate means of transport for this bulky commodity direct to the main centres of consumption. The first great area of cultivation is that on the fine rich soils surrounding the Wash. In the Holland district of Lincolnshire potatoes occupied in the census year of 1925 no less than 28 per cent of the total arable area.[1] In the neighbouring Isle of Ely the percentage was 20 per cent. The potatoes from this area are destined very largely for the London market. They are sent directly southwards by rail, and we find in London the great potato

[1] This is a romance of the last fifty years. The silt lands were formerly cattle pastures, but perseverance with disease and rot-resisting varieties of potatoes rewarded the efforts of a local potato buyer and a local farmer.

markets situated near the northern railway termini (see p. 613). The second great area is that of the Lancastrian Plain in Lancashire and Cheshire where potatoes occupied respectively 18½ and 12 per cent. of the arable area. Here the potatoes are grown on the loamy glacial soils of the lowlands and are destined, of course, to supply the great industrial towns of Lancashire. On the fertile Triassic soils of the southern part of Durham there is an important production for the industrial north-east. The moderate production in the West Riding and in Staffordshire again reflects the requirements of local industrial centres. The enormous consuming centre of London naturally encourages the growing of potatoes in Middlesex, where despite the small amount of arable land remaining potatoes occupy some 10 per cent. of the whole, whilst there are considerable quantities from Surrey and Kent also. Special mention must be made of the important movement of early potatoes from Cornwall—these being on the market before there are any available from any other parts of the country. Still earlier supplies are of course available from the Channel Islands and the island of Jersey devotes itself very largely to potato cultivation. Taking England and Wales as a whole, the average acreage under potatoes in the last ten years, 1921–30, was nearly half a million, and the ten-year average yield was 6·3 tons per acre, giving a total production for England and Wales of over 3,000,000 tons. The total production of the British Isles is something of the order of 8,000,000 tons per year. It should be noticed, especially in England, that in addition to these amounts, which are obtained from the agricultural returns, potatoes are largely grown in gardens and on allotments. It is, indeed, assumed that in England and Wales one half of the allotment area is planted with potatoes, giving an estimated production of an additional 400,000 tons in the country. It will be apparent from what has already been said that the potato cultivation in the British Isles is one which requires attention because it is difficult to see how overseas supplies of potatoes could take the place of those produced at home, simply because of the nature of the commodity. It is one, therefore, that is deserving of the continued attention of British growers.

Turnips and Swedes.—The principal root crops grown for animal fodder in this country are turnips, swedes, and mangolds; but a small proportion of the turnips are used for human consumption and these will be considered separately under vegetables. In general, these root crops demand conditions similar to those necessitated by potatoes—good, deep soil free from stones, otherwise the roots cannot form freely. They are, however, largely grown as winter feed for sheep and, to a less extent, for cattle; and it is often possible to correlate a reduction in the acreage, especially under turnips and swedes, with the reduced sheep population of the same

areas. As winter feed for stock the crop plays a vital part in British agriculture and is also an essential element in the rotation of crops. The yield is liable to fluctuations from year to year as in the case of all root crops, but over a wide area the variations are not apparent, and in Scotland the average for the years 1917–26 was 17 tons per acre. The crop is widespread, but the greatest density is in the east, especially in the north-east where, however, growth is often checked by early autumn frost. In England and Wales there has been a steady decline in the area under turnips and swedes. In 1880 the crop occupied 11 per cent. of the arable area of the country. In the census year of 1925 the area so occupied was only 7½ per cent. The heaviest yield is in the northern and north-western or the damper counties where it is from 14 to 17 tons per acre. Most of the Welsh counties exceed 14 tons per acre. In Ireland the area occupied by swedes is surprisingly large. In the Irish Free State the crop ranks third in acreage after oats and potatoes, and in 1931–2 occupied one-fifth of the cropped land, the yield per acre also being good—over 15 tons—so that the quantity produced by weight is nearly double that of potatoes. The distribution of the crop in Ireland tends to show, however, that the conditions favouring the growth of cereals also favour the growth of turnips and to some extent potatoes and turnips are mutually exclusive. There are comparatively few in the damper western fringe and the Central Plain where the potato, quite definitely, is king. In Northern Ireland turnips are not as popular as potatoes, and only occupy roughly a quarter of the acreage. It need hardly be mentioned that most of the turnips and swedes do not leave the farms in which they are grown. In the Irish Free State it is estimated that over 99 per cent. are actually used on the farms where produced.

Mangolds.—It is extremely interesting to compare the distribution of mangolds with the distribution of turnips and swedes. They form, of course, the other great root crop. In the first place the acreage under mangolds in Scotland is negligible. The summer is too short, the crop too susceptible to frost for there to be any extensive cultivation north of the English border. On the other hand, in England, especially in the drier and warmer south, mangolds grow well and in those areas are definitely superior to turnips and swedes. In the first place the yield per acre is higher. The average for the whole of England and Wales is 19 tons per acre and it reaches from 24 to 27 tons per acre in the rich soils surrounding the Wash, in the Holland district of Lincoln and in the Isle of Ely. Although the actual acreage under mangolds has changed little in England and Wales since 1880, with the general decrease in the total area of arable land, this represents a fairly general increase relatively to the arable land, and illustrates the increasing

popularity of mangolds and their superiority over other root crops. The distribution of the mangold in Ireland is extremely interesting. Of very slight importance in the early years 1847–56 when they occupied only 19,000 acres, mangolds have gained steadily in popularity and occupied over 80,000 acres in 1932. This represents between 5 and 6 per cent. of the cropped area, and mangolds share with sugar beet the distinction of being in the Irish Free State the only crop occupying a definitely increasing area. But the crop is still largely restricted to the valleys of the southern part of the country; in Northern Ireland the acreage is still negligible. Is it that the summer is too short in Northern Ireland for the successful cultivation of the crop? Or can it be that in the course of nearly a hundred years the knowledge of the superiority of this crop over turnips and swedes has not yet penetrated to the farming population of the extreme north-west?

Sugar Beet.—The cultivation of sugar beet in the British Isles is a post-war development. The major controls involved in determining the distribution of cultivation are geographic, the local are economic. Questions of soil and climate tend to limit sugar beet cultivation to areas of good, deep, well-drained soil where there is not excessive moisture. Thus there is a concentration of cultivation in East Anglia and in Ireland a corresponding one in the south-east. In Scotland the good friable soils of Fifeshire are of the greatest importance. The economic considerations are closely bound up with transport costs. The beet is heavy and usually transport costs limit the area from which any given sugar factory can draw its raw material. This factor will be considered in the special section on beet sugar production given below.

Miscellaneous Fodder Crops.—Although in the aggregate miscellaneous fodder crops occupy quite a large area the main cause for surprise is that when compared with the staples they are insignificant. The area which they occupy in England and Wales is roughly a quarter of a million acres, with approximately equal areas of 70,000 acres in each case for vetches, rape, and fodder cabbage. There are much smaller areas under fodder mustard, lucerne and kohlrabi. Lucerne is particularly popular in the south-eastern counties—in Essex, Kent, Norfolk, and Suffolk. In Scotland rape is the most popular crop; in Ireland, on the other hand, cabbages. In the Irish Free State cabbages, mainly fodder cabbages, occupy 24,000 acres of land and the value grown exceeds a million pounds annually. Two things strike one about these miscellaneous fodder crops in the British Isles. The first is the almost complete absence of maize grown as a green fodder crop. Birds steal the seeds, growth is very poor in dry seasons, autumn frosts do great damage. Similarly, it is rather surprising to find lucerne occupying such an insignificant position in this country;

Flax.—Flax can be grown either for fibre or for seed, and it is rarely that the plant can be made to yield both, since flax required for fibre has to be pulled before the seeds are ripe. The growing of flax for fibre, once important in England, is now almost entirely restricted to Northern Ireland. The output is even now insufficient to provide all the raw material required by the mills of Belfast and the neighbouring linen mill towns. Flax requires a very well drained, clean, heavy soil. The seeds are planted closely together, since the closer together the plants can be made to grow, the finer the

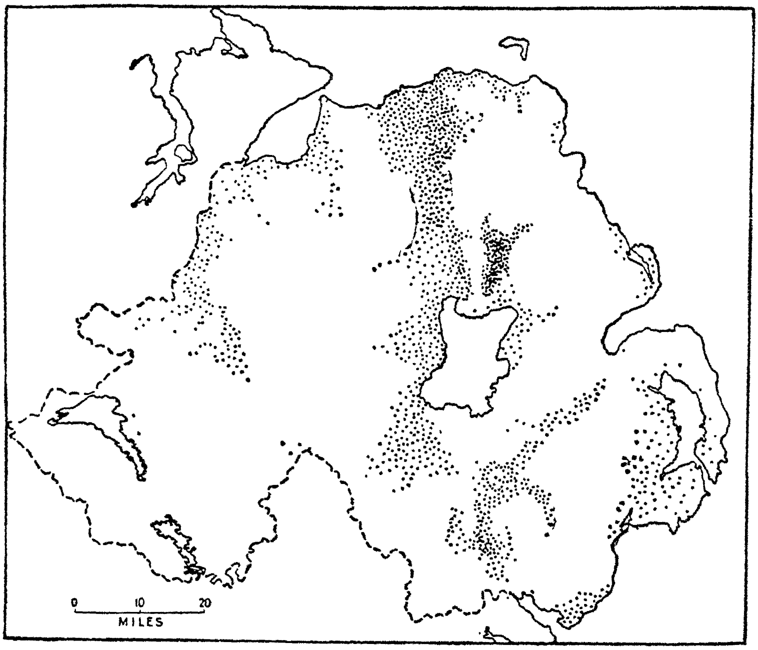


FIG. 95.—Map showing the distribution of flax in Northern Ireland. Each dot represents 25 acres in 1928.

stems and the better the fibre. The plants require constant attention—such as hand weeding. Flax is usually grown in a seven-year rotation with other crops. Soil and a suitable labour supply are really more important than climate. Cultivation is now most important on the heavy basaltic soils of the lower Bann valley, and to the west of Lough Neagh, and especially in the valley of the Main to the north of the Lough. In England there was a temporary resuscitation of flax growing for fibre in the years 1918 and 1919, just after the War, when the crop occupied 11,000 acres. But as early as 1925 the area had sunk to just under 700 acres—mainly in Somerset and Yorkshire. Flax has been grown at Sandringham since 1931 and it is hoped to use 1,000 acres. A factory was estab-

lished in 1935 at West Newton for retting. Flax is grown for linseed in England and Wales, over rather larger areas, particularly in the eastern counties.

Hops.—In recent years about 20,000 acres (decreasing) have been occupied by this crop. Considerably more than half is in Kent—on the northern slopes of the Downs and in the Weald. The other centre of cultivation is the county of Hereford and the neighbouring parts of Worcester and Shropshire. Over most of the remainder of the British Isles there is really no hop cultivation. The old expensive method of providing hop poles has now largely been replaced by a permanent or semi-permanent arrangement of heavier poles with wires. But the great problem of the hop industry is the labour requirement at the time of harvest. In the Kentish area, this labour is derived almost entirely from London, and for periods of a fortnight or three weeks large numbers of East End workers are brought down for what is to them and their families an annual country holiday. Hops are required, of course, to give the bitter flavour to beer. The oast-houses in which hops were dried and stored are still familiar features in south-eastern England. Many of them are disused now that there is a centralisation in the collection and marketing of hops.

Vegetables grown for Human Consumption.—In recent years the increasing acreage under market garden crops has been very marked, as the following table shows:

England and Wales

Crop	1922	1922–30	Acreage 1932	Production 1925 census
			Acres	Tons
Green peas	50,418	48,675 [1]	60,800	72,700
Green beans	12,684	12,782 [1]	14,400	33,900
Cabbage for human consumption	27,954	26,784	33,900	410,000
Brussels sprouts	14,951	22,876	32,900	93,000
Cauliflower and broccoli	10,475	12,504	17,600	162,000
Carrots	14,084	9,935	12,500	110,000
Turnips for human consumption			9,000 [2]	100,000
Onions	3,557	2,276	1,900	17,100
Celery	5,282	5,581	7,700	37,300
Rhubarb	5,718	6,522	8,300	60,300
Other vegetable crops	—	—	21,200 [2]	—
Flowers (grown in the open)	—	—	5,250 [2]	—
Nursery stock	—	—	10,000 [2]	—
Glasshouse produce—				
Tomatoes	—	—	—	47,000
				No.
Cucumbers	—	—	—	50,000,000
				lbs.
Grapes	—	—	—	1,500,000

[1] 1926–30. [2] 1925 census.

Table from "Recent Developments in Market Gardening," Rothamsted Conference XV (1933).

The industry in the British Isles is one of market gardening rather than that which is known on the other side of the Atlantic as truck farming. The two factors which most strongly influence the distribution of vegetable cultivation are, first of all, the presence of suitable soil, and in this respect good, deep, rich soil, such as we have mentioned in the case of potatoes, is required. Earliness is one of the great qualities in a market garden soil. In the second place transport facilities (or the nearby presence of markets) must be good. Thus there is a great deal of intensive market gardening in such a county as Middlesex for the supply of London's markets. On a larger scale vegetables are grown, particularly in the rich soils of the Fens. For example, nearly a quarter of the total area under turnips is in the small county of the Isle of Ely alone, for the supply of London. Bedfordshire is also an important market gardening county—Sandy has been famous for more than a hundred years—but a very large proportion of London's vegetables come from the rich belt of mixed soils in northern Kent. The East and West Ridings of Yorkshire play an important part in the supply of vegetables in the northern counties. The influence of climatic conditions has been observed to be of marked importance in recent years in relationship particularly to Cornwall, where many vegetables are ready for market before they are in other areas. There has even developed in post-war years an export trade in broccoli. Reference will be made below to the remarkable fillip given just recently to the growing of vegetables by the development of the British canning industry.

Small Fruit.—The bulk of the small fruit grown in England and Wales may be found in three areas. The most important of these areas is Kent, especially on the mixed soils of the fertile northern belt of the county. The fruit growing area also stretches into the neighbouring counties of Sussex, Essex, Middlesex, and Surrey to some small extent. The second is that which lies round the Wash and which includes parts of Norfolk, Cambridge, the Isle of Ely, and the Holland district of Lincoln, and has an important centre at Wisbech. The first of these areas has about a quarter of the total acreage for England and Wales, the second about a third. The third tract is the county of Worcester together with neighbouring parts of Gloucester and Hereford. Hampshire has, in addition, important areas devoted mainly to strawberries, whilst Devon and Cornwall have also important acreages. Some 40 per cent. of the area devoted to small fruit is under strawberries, another 40 per cent. under currants and gooseberries, leaving only 20 per cent. for raspberries and the remainder. In Scotland there is similarly a concentration of small fruit cultivation. By far the most famous area is, of course, the Carse of Gowrie with its suitable soils, its comparatively low rainfall, its sunshine and its southern

aspect. The great difficulty in the British Isles with regard to the cultivation of small fruit is the short ripening period in the summer; in other words, the markets are suddenly glutted for about a fortnight with each type of fruit, when there is suddenly a supply in considerable excess of the demand. This is being coped with to a considerable extent by the new canning industry.

Orchards.—Orchards are of negligible importance in both Scotland and Ireland. Apart from the quite considerable production of orchard fruits from isolated trees in gardens, regular orchards probably include about 25,000,000 trees in England and Wales. Sixty per cent. of these are apples, plums come next with 30 per cent., pears about 8 per cent., cherries and all others forming the remainder. In England and Wales three groups of counties contain the bulk of the orchards. Kent, again the fertile northern stretch, leads with over 50,000 acres (census of 1925), Worcester, Hereford, and Gloucester come next with almost as many, then followed by Devon and Somerset. These three areas have two-thirds of all the fruit orchards in the country. Included under "other fruit trees" are nut trees. The average yield of orchard fruit is far more variable than that of small fruit, and the following table for two consecutive years illustrates this extraordinarily well.

AVERAGE YIELD PER TREE OF ORCHARD FRUIT IN 1924 AND 1925

Description	1924	1925
Apples—	lbs.	lbs.
Dessert and cooking	23·4	60·3
Cider	49·6	47·6
Pears—		
Dessert and cooking	34·4	5·1
Perry	300·2	11·1
Plums	15·3	17·6
Cherries	31·2	52·8

In any given orchard there is often an alternation of low and high yields per tree. A large proportion of the apples grown in this country are cider apples. This is particularly the case in the orchards of Herefordshire, Somerset, and Devon, which are the great cider-making counties. In many parts of the country cider takes the place of beer as the natural local drink, and it is widely appreciated all over the country. Perry, a comparable beverage made from pears, is not nearly as widely known, and is more restricted to the west country. For many years it has been the practice in the west country to replace gaps in cider orchards by apple trees of dessert or cooking varieties, so that there has been a tendency for a general reduction in the production of cider apples and a greater production of dessert and cooking apples. The newer orchards are of the same types. It is curious how ideas which

are detrimental to some branch of industry sometimes gain wide currency and are increasingly difficult to refute. Some such ideas refer to apples. It is that, with the possible exception of Cox's Orange Pippins, the British Isles do not produce dessert apples for keeping after Christmas, and that we must therefore remain dependent on foreign supplies of apples, particularly from the Dominions. Research has shown that we have a number of excellent apples of good keeping qualities which can be kept in ordinary cellars until after Christmas, whilst with the extension of proper storage facilities there is no reason at all why excellent dessert apples of home origin should not be available for British markets throughout the year. At the present time extensive experiments are being carried out in storage controlled by low temperature gas.[1]

Flowers.—The output of flowers grown for sale in this country is probably of the order of £2,000,000 sterling per year, and the flowers grown in the open occupy some five or six thousand acres at the least, apart from the very large areas under glass. Daffodils, narcissi, tulips and violets occupy large areas, the first three being grown very extensively in the light, friable but rich soils round the Wash and particularly in the Holland district of Lincoln ; and it is in the neighbourhood of Wisbech that one finds the bulb farms rivalling the much advertised farms of Holland—not only rivalling them in size but certainly in quality of products. It is an interesting pilgrimage for the motorist to visit one of our own bulb farms in this area. An interesting development of the industry is that in Cornwall (including the Scilly Isles) where, owing to the mildness of the winter, flowers for the London market can be produced as early as January, and the trade is at its height from January to April.

Glasshouse Products.—The 1925 Census of Production estimated that commercial glasshouses in England and Wales covered 2,725 acres. The home counties in a ring round London account for more than three-quarters of the glasshouses and of course supply largely the London markets. The western side of the Lea Valley between Ponder's End and Broxbourne, centreing in Cheshunt and Waltham Cross in Hertfordshire, is probably the most intensively cultivated area in the world, with a thousand acres under glass. Tomatoes are by far the most important crop, and the value in 1925 was estimated at £2$\frac{1}{3}$ million sterling (for 47,000 tons produced). Other glasshouse crops include cucumbers, grapes and other fruit and vegetables, with a large variety of flowers and plants.

The Distribution of Live Stock in the British Isles

Horses.—It is a matter of greatest difficulty to get a correct view of the distribution and importance of the horse in the British

[1] The research stations at Long Ashton and at Malling near Maidstone are doing much to foster scientific intensive fruit farming.

Isles at the present day. The published statistics are misleading in that they refer to horses on agricultural holdings, and are based on returns made by farmers. Taking first the horses recorded in this way, there has, as one might expect, been a steady annual decrease in recent years, which cumulatively over the post-war years has been really very rapid. In 1921 there were recorded on farms 1,384,587 in England and Wales, 216,621 in Scotland, 100,400 (agricultural only) in Northern Ireland, and 490,183 in the Irish Free State. Ten years later, in 1931, the numbers had fallen to 938,494 in England and Wales, 152,668 in Scotland, 86,486 in Northern Ireland, and 449,697 in the Irish Free State. The horses on agricultural holdings are divided into three classes: horses used for agricultural purposes, including mares kept for breeding, unbroken horses—that is mainly young stock—and other horses which are saddle and carriage horses and vanners. The general decrease is in all categories, and the report of the 1925 census notes the very large decrease in unbroken horses, which really represented the decline in horse breeding and the production of young stock. One might urge at once that the decrease in the number of agricultural horses is due to the increased use of mechanical farm implements—tractors, steam or motor ploughs, etc. Yet the remarkable feature which comes out in studying the figures carefully is that over a long period of years the decrease in the number of horses has often not been as rapid as the decrease in land to be ploughed. Thus, taking the figures for Northern Ireland as an example, in the decade 1854–63 there was one horse for every 10·1 acres of ploughed land. In 1923–7 the proportion was as high as one per 6·2 acres despite the use of mechanical tractors. This would suggest that the number of horses kept on farms in this country is really too large, but the number of horses also depends on the system of farming. Turning to horses other than those used on farms, similar declines are, of course, noticeable, though it is difficult to get actual statistics. Standing rather by itself is the breeding of horses as hunters, race-horses and others for pleasure purposes, and with this the production of bloodstock for export. Taking as an example the well-known race-horse breeding industry of the Irish Free State, particularly in the hinterland of Dublin in Kildare, one finds that in the census year 1926–7 no less than 11,128 horses, valued at £1,425,000, were exported. There was at the same time an import of 2,435 horses valued at £393,000, practically all of them going to breeding establishments. This gives a net export of horses from the Irish Free State valued at over £1,000,000 sterling in that census year. In Britain as a whole the location of breeding establishments is determined to a very small extent by natural conditions, but usually by proximity to well-known racecourses. Thus there are such centres of breeding as Epsom and Newmarket, and a rather

disturbing feature in recent years has been the way in which the horse-breeding establishments have, by reason of greater capital available, bought up farms and caused the conversion of some of the best arable land in the country into gallops for exercising the horses.[1]

Cattle.—In the year 1931 there were nearly 12,000,000 cattle in the British Isles; of these 6,065,000 were in England and Wales,

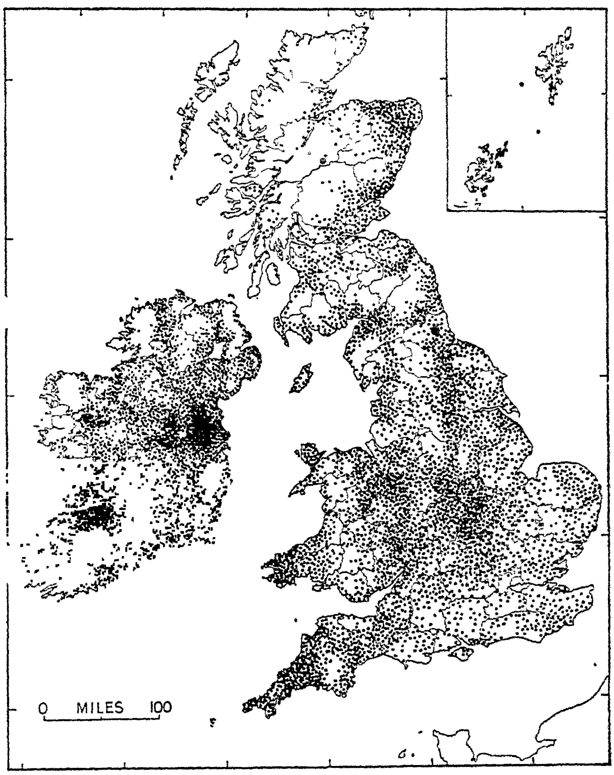


FIG. 96.—Map showing the distribution of beef-cattle in the British Isles. Each dot represents 1,000 animals in 1931. For explanation, see text.

1,109,000 in Scotland, and the remainder in Ireland. There is a broad distinction into dairy cattle and other cattle, and in the broadest possible way it may be said that half the cattle in the British Isles are kept for the production of milk and the other half for the production of beef. It is scarcely necessary to remind ourselves of the growth of the cattle-farming industry—both dairy farming and

[1] This fact was revealed in some areas by the Land Utilisation Survey, but it is only fair to state that downland is still the most widely used.

beef rearing—at the expense of crop farming. We have seen the high value of products, of live stock and dairy produce and a tendency for those values to increase. This is as it should be when one considers the advantage of a supply of fresh milk and the advantages of home-killed beef and veal. We are inclined to compliment ourselves on the progress which this most important branch of farming has shown, but the table given below (which refers to England and Wales) brings out several interesting points. Although the number of cattle has increased more or less steadily from 1867 onwards,

	Nos. of cattle per 1,000 acres of land under cultivation			Nos. of cattle per 1,000 of population		
	Cows and heifers in milk or in calf	Other cattle	Total	Cows and heifers in milk or in calf	Other cattle	Total
1867–76 . .	68·0	104·1	172·1	77·7	119·0	196·7
1877–86 . .	70·1	109·4	179·5	73·6	114·9	188·5
1887–96 . .	75·6	115·5	191·1	71·8	109·6	181·4
1897–06 . .	79·7	121·7	201·4	66·9	102·1	169·0
1907–14 (8 yrs.)	86·4	127·0	213·4	65·6	96·5	162·1
1915–24 . .	94·6	129·2	223·8	69·0	94·2	163·2
1925 . . .	105·3	134·0	239·3	69·8	88·7	158·5

In the year 1915 to 1920 inclusive, the population figures excluded non-civilians.

that is from the date of the first agricultural statistical record, both actually and in relation to the total cultivated area,[1] the increase has failed to keep pace with the growth of population. This is offset to some extent by the increasing yield of milk from dairy cows and the increase in the quality of the beef cattle, but in the main it has resulted in the increased dependence of this country on imports of beef and dairy products. The rearing of cattle is an industry for which the climatic conditions of this country with its open winters and its good growth of grass is pre-eminently suited, and one therefore deserving of encouragement in all directions. We will now consider separately the distribution in space of dairy cattle and beef cattle; for although in many areas cattle are dual purpose animals, the females being for the production of milk and the males for the production of meat, there is on the whole a very marked contrast in the distribution of the two types. Both dairy cattle and beef cattle require good pastures and good fodder; but apart from this there is considerable divergence.

Dairy Cattle.—Dairy cows must be milked night and morning. Tracts of pasture difficult of easy approach to the farm because of intervening tracts of moorland, bog, or mountain are of little use:

[1] The increase is partly due to the fact that cattle are now killed younger than previously.

thus we find for the successful keeping of dairy herds, the pastures themselves must be readily accessible from farmhouses. In the second place the utilisation of the milk depends very largely again on questions of accessibility. Where the farm is accessible to good road or rail transport, and is within reasonable compass of great consuming urban centres, then it is probable that the milk will be sold as such. Where the farming areas are more remote, but when

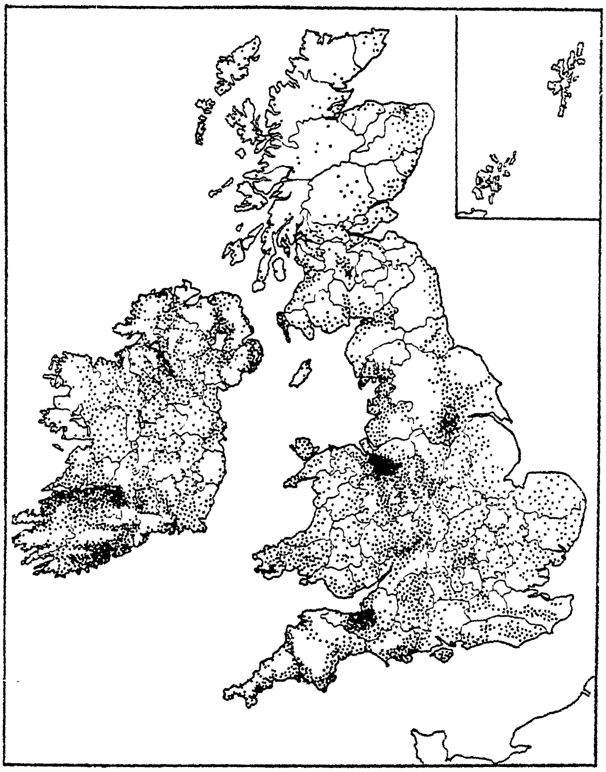


FIG. 97.—Map showing the distribution of dairy cattle in the British Isles. Each dot represents 1,000 animals (average of five years, 1924–28).

the farms are still comparatively accessible from one another, it is likely that the co-operative production of butter will result, or, in certain areas where the tradition has been established, cheese. In the butter-producing areas, there is the utilisation of the skimmed milk to be considered, and it is in such tracts that a subsidiary pig-rearing industry will tend to grow up. These general principles are well illustrated by establishing a contrast between Eire on the one hand and England and Wales on the other.

England with its vast industrial population needs huge quantities of milk which is more conveniently produced at home than imported. Ireland has not a vast milk consuming industrial population. In each country a tenth of the total yield of milk is fed to live stock, in England nearly three-quarters—71·6 per cent. in 1924–5—is consumed as milk, leaving only about a sixth (18·4 per cent.) in 1924–5 to be converted into cream, butter and cheese. In Eire, on the other hand, three-quarters of the whole is converted into milk products, mainly butter, leaving only 15 per cent. for consumption as milk. In England and Wales the same principles can be applied on a much smaller scale. It is the remoter counties, for example Cornwall and Pembrokeshire, which specialise in the production of butter, and in Scotland Wigtownshire and the south coast. The home counties as far west as Wiltshire and Somerset are sufficiently accessible to send their daily supplies of milk to London, and here another point arises. Economic considerations of the nearness of the consuming centres may cause it to be a paying proposition to keep dairy cattle under conditions which would otherwise be unsuitable. Thus one of the driest [1] English counties and one which would not be expected, therefore, to be so suitable for dairy farming as for arable farming, is Essex. But Essex has become quite an important dairying county because of its proximity to the great consuming centre of London.

We can now evaluate the map showing the distribution of dairy cattle in the British Isles. In England the first point to notice is the comparatively small number of cattle on the drier east on the predominantly arable land and their increasing importance as one goes towards the wetter west. The rich lowland pastures of such areas as Cheshire are the most suitable and the efficiency of the industry may be judged from the following figures. It was estimated that in the years 1926–7 the dairy cattle of Eire produced 487 gallons per animal compared with 535 gallons in England and Wales in the preceding year, and 645 in Denmark. In Scotland one notices the concentration on dairy cattle in the northern part of Ayrshire and around such consuming centres as Glasgow and the other industrial areas in the central lowlands. Dairy cattle become comparatively unimportant as one goes northwards owing obviously to the increasing difficulties of access. The very fertile stretch of lowland lying to the south of the Southern Uplands from Wigtownshire through Galloway also stands out. From this area milk can be sent to the Central Lowlands and also directly to the industrial areas of the north-east of England, such as Newcastle, and even to London. In Ireland there is a remarkable concentration of dairy cattle in the fine open damp valleys of the south-west, and it is in this region that co-operative dairy farming has been so effectively

[1] But note the wet clay soils.

developed. One so often reads in generalised text-books of the large number of dairy cattle in the lush grasslands of the Central Plain that it comes something of a shock to find that dairy cattle are by no means numerous in this area, and the great factor there is the difficulty of access to the pastures from the individual farms owing to the presence of stretches of bogland, and still more the difficulty of linking up the individual farms with effective means of transport. A subsidiary map has been produced for Ireland showing the percentage of all milch cows in each county which were supplying co-operative creameries in the year 1926. It illustrates the remarkable organisation which has been developed in the south-west, particularly in and around the county of Limerick. (See Fig. 123, p. 246.)

Other Cattle.—One of the most striking features in the figures relative to other cattle is the increase in the number of young stock of under two years. Cattle of two years and upwards may be assumed to be almost entirely for beef production, and below that age the animals may be either destined for the dairy herd or for the slaughter-house. This is not so much due to the increased consumption of veal in the British Isles as to the increased proportion of beef that is obtained from young animals, which, although under two years of age on June 4 in each year when they are enumerated, are slaughtered for beef before the next June 4 comes round. Turning now to the maps showing the distribution of cattle other than dairy cattle in the British Isles, in England and Wales one notices first of all the same concentration in the Midland counties where is a large proportion of good rich pasture. But if one studies the distribution of cattle on rather a different basis, namely that of a thousand acres of crop land and grassland, one finds, according to the 1925 census, the predominance of cattle in the wet western counties, such as the mountainous counties of Wales as well as the hilly areas of Devon and Cornwall and Cumberland, whilst the lowest proportions are reached in the East Anglian counties, as one might expect. In Scotland the map shows the interesting contrast compared with that of dairy cattle. There is no longer a concentration round the towns of the Midland Valley, but as one goes northwards, particularly in the great Buchan Plateau of Aberdeenshire and around the Moray Firth and further northwards, beef cattle become enormously more important than dairy cattle. What does strike one about the maps is the comparative absence, in fact one might say almost complete absence, of cattle over the main areas of the Highlands of Scotland. It is to be feared that the picturesque "Highland cattle," beloved of the artist, are conspicuous by their absence and tend to be found only in certain low-lying glens. As we shall see later, sheep are the animals of the Highlands themselves. Turning to Ireland, it would be difficult to find a more

conclusive proof of the different conditions required by beef cattle. The enormous number living on the Central Plain is the outstanding feature, and particularly the great number in the almost immediate hinterland of Dublin. One can almost imagine them waiting there to be exported in normal times to Britain for fattening and for slaughter. Naturally there are large numbers of beef cattle in the dairying regions also, but both types avoid the main mountain areas and the tracts of bogland.

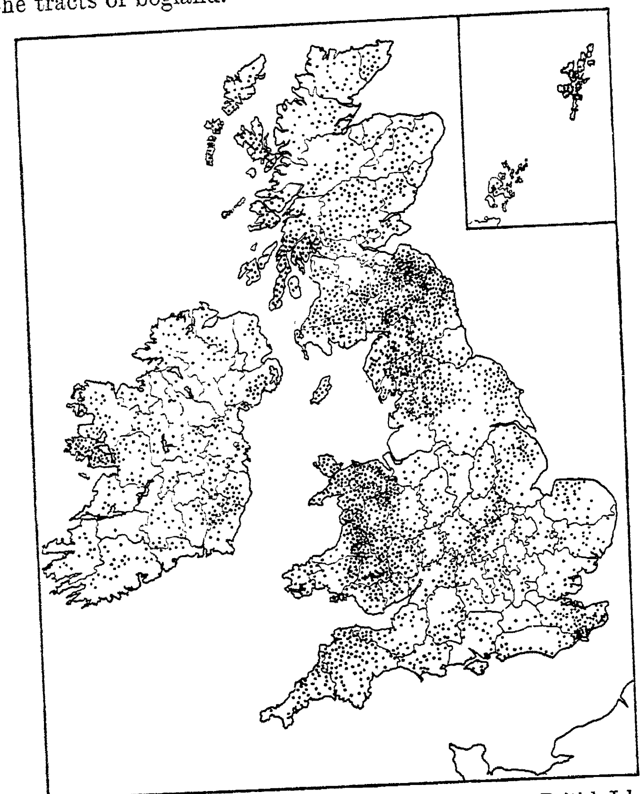


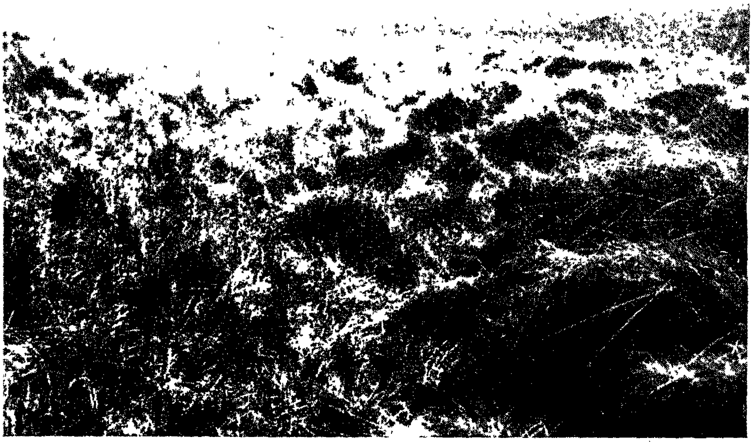
FIG. 98.—Map showing the distribution of sheep in the British Isles. Each dot represents 10,000 animals (average of 1924–28).

Sheep.—The British Isles have long been famous for their sheep. Not only was wool a staple product and export in the Middle Ages, but at a later stage British sheep became famous for their meat. Most of the British breeds are heavy animals, producing good, well-flavoured meat, and at the same time having a heavy fleece of excellent quality wool. The large sheep populations of the great grassland countries of the Southern Hemisphere, such as the Argentine, Uruguay, South Africa, Australia, and New Zealand, are

very largely of British origin. The only rival indeed of the British breeds is the merino—a wool-producing sheep suitable for arid conditions. The British Isles have still a very large number of sheep. The number has been increasing steadily of recent years, and in 1932 there were over 30,000,000. Of these 18,480,000 were in England and Wales, 7,900,000 in Scotland, and 4,250,000 in Ireland. This is a larger number than is found in the whole of New Zealand despite the fact that two of the staple products of New Zealand are mutton and wool. The number in the whole of Australia is only about 100,000,000—little over three times the number in the small area of the British Isles. When one remembers the dominantly damp character of the climate of the British Isles these few figures ought immediately to do away with the fallacy that sheep cannot thrive under damp conditions. The actual facts are that the amount of rainfall or moisture is more or less immaterial provided the drainage is good. It is in waterlogged, low-lying pastures that sheep give place to cattle, and where, if an attempt is made to keep them, they suffer from diseases of the feet as well as an unsuitable diet. Sheep are the animals of the moor and hill pastures, and of the short wiry grass of the limestone hills, though they enter into the economy of a large number of mixed or general farms. These facts are well borne out in general by a study of the map. In England and Wales there is a large sheep population on the hill pastures of Wales, in the Lake District and on the Pennines. They are obviously numerous on the limestone pastures of the south-east. There are areas, however, where sheep are important despite the fact that one would not expect them to be. This is particularly the case in the flat drained marshland of the Romney Marshes in Kent, where the Romney sheep are especially famous.[1] In Scotland the huge numbers of sheep on the upland pastures of the Southern Uplands is particularly noteworthy, more especially in the drier eastern regions in the Tweed Basin. In the Central Lowlands sheep are not numerous on the low-lying ground, but are by far the most important animals on the hill pastures of that line of volcanic hills which runs across the Midland Valley parallel to the Highland boundary fault. Then the map shows at once the great importance of sheep throughout most of the Highlands of Scotland, including, it will be noticed, the western islands. In Ireland the distribution of sheep is extremely interesting. They are seen to be concentrated especially in two areas: on the slopes of the Wicklow Mountains in the east, and on the west in the heart of Galway, where there is a large outcrop of Carboniferous Limestone unmasked by drift. There are also considerable numbers of sheep in Ireland in the hilly and mountainous areas of Connemara, Mayo,

[1] But the corresponding Pevensey marshes are devoted to cattle, largely because running water for drinking purposes is available.

and Donegal as well as on some of the hills in the south-west; whilst in Northern Ireland they are numerous, particularly on the uplands of County Down, the natural continuation of the Southern Uplands of Scotland. It must be remembered that the statistics on which these distribution maps are based are collected by the Government Departments concerned, and refer to the state of affairs on June 4 of each year. They do not, therefore, illustrate the very extensive migration of sheep which takes place in most of the larger sheep-rearing districts. An excellent example is afforded by Cumberland, where the sheep are kept up on the hill sides (or "fells")



[*Photo: L. D. Stamp.*

FIG. 99.—*Nardus* grassland—rough hill pasture capable of extensive improvement by burning and seeding.

Experimental Farm, near Devil's Bridge, Wales.

in the summer months, but in winter are driven to the pastures of Solway Plain. The same migration is found in the Welsh region as well as in the Highlands of Scotland and in many other tracts. There are obviously two factors in operation. One is climate. The mountain pastures are often cold, bleak, and snow-covered in winter; but far more important is the character of the pastures themselves, which actually provide food only in the summer months. Important studies have been made in recent years by the Welsh Plant Breeding establishment at Aberystwyth under the guidance of Sir George Stapledon.[1] He has pointed out that, after the

[1] "Climate and the Improvement of Hill Land," *Geography*, XVIII, 1933, 17–25. *A Survey of the Agricultural and Waste Lands of Wales.* London: Faber and Faber, 1936. E. Davies: "Sheep-farming in Upland Wales," *Geography*, XX. 1935, 97–111. Compare C. S. Orwin, *The Reclamation of Exmoor Forest.* Oxford University Press, 1929.

Napoleonic Wars, isolated but well chosen areas in narrow fields were ploughed for oats on the Welsh Hills up to 1,500 or even 1,700 feet, and that these areas can still be distinguished in that they afford better pasture than the surrounding rough pasture. It is clear from these patches, with their comparative abundance of *Agrostis* rather than Fescue grass, and the occurrence of white clover and such weeds of cultivation as hawksweed, that the surrounding areas of pasture might in any case be much better than they are. A rough estimate shows that in Wales alone there are something like 2,000,000 acres of rough hill pastures, and of these possibly 1,000,000 acres are of grass, of which Sir George Stapledon considers that something like half is favourable from the point of view of aspect and other considerations for improvement. The very wet areas of cotton grass, sphagnum and other types of bog would be expensive to drain, but there remain three types of grass pasture in Wales which are suitable for consideration: (1) *Molinea* or flying-bent pasture; (2) *Nardus* or wet-grass pasture; (3) Bent-fescue pasture. The natural defects of these pastures are that *Molinea* is deciduous and is only used by sheep feeding for about one month; *Nardus* is unpalatable to sheep, and whilst the bent and fescue are palatable they are of low feeding value, particularly in that they lack lime. Further disadvantages are the lack of leguminous plants—that is, plants of the pea and bean family—such as white clover, and of herbs such as daisies, which have an excellent feeding value. The need is to introduce the white clover, and more palatable grasses with a longer growing season. Even by the simple process of cutting off, grazing hard and then manuring, the bent and fescue, *i.e.* the better grasses, are increased in numbers; thus large areas of our hill pastures might easily be improved. The method suggested is to fire, then to scratch the surface by tractors, then to manure with basic slags and nitrate chalk, and then to scatter seeds over the surface, especially of wild white clover. It may be necessary to distribute small quantities of soil from lowland regions which is inoculated with the nitrogen bacteria necessary for the life of a leguminous plant such as clover. Surface sowing on these hill pastures is possible because of the extreme moisture of the climate. This is an advantage of the climate which otherwise is far from favourable. The main trouble is not the excess of rain, but an excess of misty damp days producing a soggy ground and a humid atmosphere. It is claimed that 10–15 per cent. of the land of the sheep walks might be improved, and by the proper alignment of fences this improved land could be used in such a way that each of the major sheep walks had a proportion of it. Much also might be done by the planting of trees as shelter belts, and it would be quite possible therefore that sheep could be kept out on the fells or hill pastures throughout the year. Heather moorlands could

doubtless be improved in the same way, probably by the simple process of burning, since it is seen that heather itself has an important nutritive value for sheep feeding. It would probably pay also to keep limited numbers of cattle on the hill pastures, not because the cattle themselves could be expected to pay, but they would gradually benefit the ground by their manure.[1] In the meantime, until such improvements can be carried out, the sheep can only be kept on the hill pastures for a short season of the year. In the winter they are in the main responsible for the consumption of the turnip crop and other root crops.

[Photo : L. D. Stamp.

FIG. 100.—" Fell " sheep in Central Wales.

It should be noticed that the number of sheep in the British Isles fluctuates somewhat considerably from year to year. Weather conditions during the lambing season play a big part in the variation in the total number of sheep. It must be remembered that large numbers of sheep are slaughtered as young animals. Thus, compared with 7½ million sheep in Scotland, something like 2½ million are slaughtered every year ; and the annual production of Scottish mutton and lamb, for example, during the five-year period 1921–25, was well over 1 million cwt. The average of the same five years shows that over 5 million sheep and lambs are slaughtered annually in England and Wales, producing nearly 2½ million cwt. of mutton and lamb.[2] By way of comparison the wool cut averaged in the

[1] On the chalk pastures of the south cattle are beneficial in that they tread down the grass.

[2] One of the marked changes of recent years has been the reduced production of winter mutton on arable land and the increased production of spring and summer lamb on grassland.

same years 20 million lbs. in Scotland, and 50 million lbs. in England and Wales. In addition to this, 6 million lbs. was obtained from the carcasses of slaughtered sheep in Scotland and 15 million lbs. in England and Wales.

One of the most remarkable features of the sheep-rearing industry in the British Isles is the local distribution of the main breeds. Thus in Scotland some 60 per cent. of the sheep are black-faced

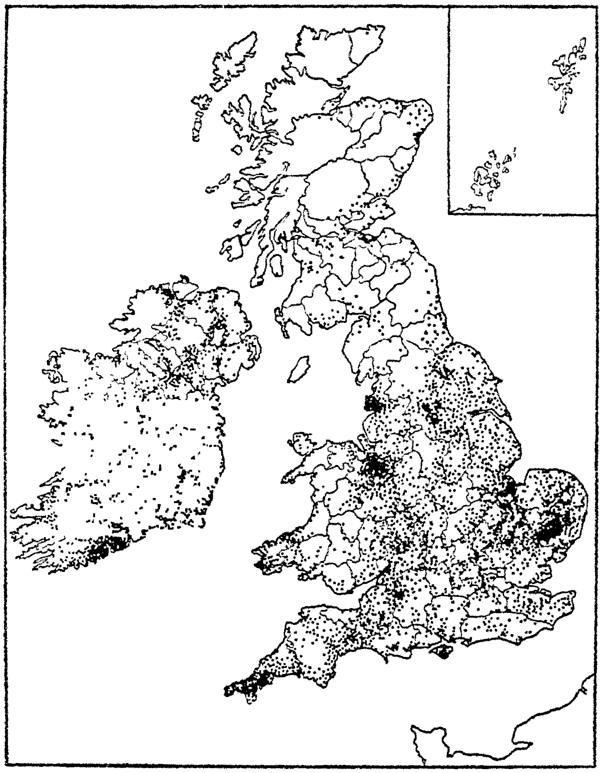


Fig. 101.—Map showing the distribution of pigs in the British Isles. Each dot represents 1,000 animals in 1931 (Ireland, 1929).

sheep, over 25 per cent. are Cheviots, the former predominating on the higher and more exposed districts of the poorer pasturage, the Cheviots common on lower ground, especially in the east. In England and Wales there are the Welsh mountain sheep of the uplands, and the breeds whose habitat is defined by their names, the Leicester and Lincoln breeds being particularly famous on the drier pastures of the eastern counties, the Southdown sheep on the South Downs, the specially adapted Romney Marsh sheep on Romney Marsh. These are but a few of the large number of breeds.

Pigs.—By comparison with sheep and cattle, pigs are essentially domestic animals. They are kept usually in small numbers by the farmer or smallholder. On the whole the pig population in England and Wales is densest in the eastern counties, such as Middlesex and also the Isle of Wight, whilst the smallest numbers are found in the hilliest parts of the sparsely populated counties such as Northumberland, Cumberland and Westmorland, and in Wales. The peculiar nature of the pig's diet is often responsible for considerable density near the large towns. This accounts for the density in Middlesex, and it is apparent also in some parts of Scotland. It is in Ireland especially that one notices the connection between pig rearing and dairy farming. In the south-west, where butter is so extensively made, the pigs are largely kept on the skimmed milk thus produced in quantities. The total number of pigs, however, in the British Isles is not large—about 3½ million in England and Wales, and only 200,000 in Scotland—whilst even in Ireland, where the pig is most closely associated with smallholdings, the number only reaches about a million. Pigs are largely slaughtered for the production of pork, and reference will be made later to the difficulties of the bacon industry.

Poultry.—It is by no means easy to assess the relative importance of poultry and poultry farming in the British Isles. The returns made to the Ministry of Agriculture are only from agricultural holdings of one acre and over in extent, and there are many keepers of poultry who have far less ground than this. Furthermore, many farmers do not accurately know how many poultry they have, and in any case often tend to regard them as of minor importance. Such returns as exist seem to indicate that there are about 40 million poultry in England and Wales, 6 million in Scotland, 3 million in Northern Ireland, and 23 million in the Irish Free State. Some 85–90 per cent. of the poultry are fowls. Taking England and Wales, one notices first of all a concentration of poultry keeping in the south-eastern counties around the Metropolis and in Lancashire and the surrounding counties. In 1924 the density in Lancaster was far greater per thousand acres of crops and grass than in any other county. Lancashire is also amongst the leading counties in the matter of ducks, followed in turn by certain of the eastern counties. Geese, on the other hand, are kept to a much greater extent in Wales than in England. East Anglia is pre-eminent for the raising of turkeys, especially Suffolk and Norfolk. In Britain three points are undoubtedly outstanding. One is a considerable increase, so far as one is able to judge, in the total number of poultry. Poultry farming is, on the whole, a smallholder's occupation. It is at once an attractive yet dangerous form of farming for the man with a little capital. It is just as dangerous to undertake poultry farming without knowledge and experience as it is to undertake any other form of farming. The marketing of his produce is an outstanding difficulty for the small poultry farmer. In the second place there is evidence of an increased efficiency in the egg-laying capacity of fowls, but so far as it is possible to get figures, it seems that only about 100 eggs, or two eggs per week per fowl, has been reached through the country. This is a figure which could be greatly improved. In the third place there is still a large import of eggs and poultry. There is undoubtedly a possibility for the extension of this industry on a large scale. The recent attempts at canning roast fowl are likely to prove successful, and to open up new possibilities.

Ireland deserves to be separately considered because one of the most remarkable features of Irish agriculture is the almost uninterrupted increase in the number of poultry from 1847 to 1930. There is an export, both of poultry and eggs, from Northern Ireland, whilst from the Irish Free State over a million live poultry are exported annually, and another 100,000 cwt. already killed. Many chickens are sent over alive, but most of the Christmas turkeys, being for quick sale at the cold time of the year, are killed first. The value of the poultry exported is in the neighbourhood of £1,000,000 annually, but even this is small when compared with the £3,000,000 worth of eggs which are exported in normal times mainly to Great Britain.

Types of Farming

The preceding pages have given a general account of the distribution of crops and animals over Britain but have to some extent failed to indicate the part they play in the different types of farming economy. It is usual to distinguish *pastoral farming*, *crop farming*, and *mixed farming*. In a recent publication the Ministry of Agriculture distinguishes six types based essentially on grassland (dairying, dairying supplemented by other enterprises, grazing and dairying, rearing, rearing and sheep grazing), six intermediate types (mixed farming with substantial dairying, mixed farming with rearing or feeding, general mixed, corn-sheep-dairying, wheat-cattle, mixed farming with fruit, vegetables or hops), and six types based on arable (mixed farming based on arable production, corn-sheep, corn-sheep with cash crops, cash crops, market gardening, other arable types). This is an economic classification based on the cash return to the farmer and the map of England and Wales showing the distribution of the types is very instructive.[1]

Certain types of farming, delightfully described in a small book by J. A. Scott Watson,[2] are particularly distinctive, and include (*a*) mountain sheep farming of the hilly regions of Scotland, Wales, and the Pennines; (*b*) beef-cattle farming, especially the fattening of the English midlands; (*c*) corn-sheep mixed farming of the downlands; (*d*) crop farming of the east; (*e*) dairying; and (*f*) alternate husbandry—ordinary mixed farming.

Number and Size of Agricultural Holdings

The total number of agricultural holdings in England and Wales has tended to decrease of recent years, and in 1931 was 392,000. Very roughly 40 per cent. of these are under 20 acres in extent, and may be classed as smallholdings. This percentage has tended, on the whole, of recent years to decrease. Small farms of from 20 to 50 acres numbered 77,400 in 1931, or about 20 per cent. of the whole. Larger farms of from 50 to 150 acres numbered 94,000, or nearly 25 per cent. The remainder, 47,000 in number, are over 150 acres. In Scotland the number of holdings is rather under 76,000, and they are there classified somewhat differently; 59,500, or almost exactly two-thirds, are under 50 acres in extent, and these smallholdings have shown a marked decrease in numbers since pre-war years. The number of larger farms has also decreased, but not to the same extent. In Northern Ireland the total number of farms is approximately 127,000. The predominance of smallholdings here, as in the Irish Free State, is very marked indeed. Only 13 per cent. of these are holdings exceeding 50 acres in extent, as against 87 per cent. of less than 50 acres. More than 28,000 are recorded as between 15 and 30 acres in extent. This may be regarded as the most common size.

[1] Types of farming map of England and Wales, with explanatory bulletin, 1941, obtainable from the Land Utilisation Survey, London School of Economics.

[2] *The Farming Year.* London, Longmans, 1936.

Some Agricultural Industries

Sugar Beet.—The world's first beet-sugar factory was established in Silesia, Germany, in 1801. The new industry soon attracted the attention of Napoleon, who saw in fostering the home production of sugar a means of breaking the power of the British Empire which had at that time almost a monopoly of sugar production. Napoleon may be regarded as responsible for the initiation of the subsidy system under which the industry grew in many European countries. Before the Great War, in the years 1909–1913, so important had

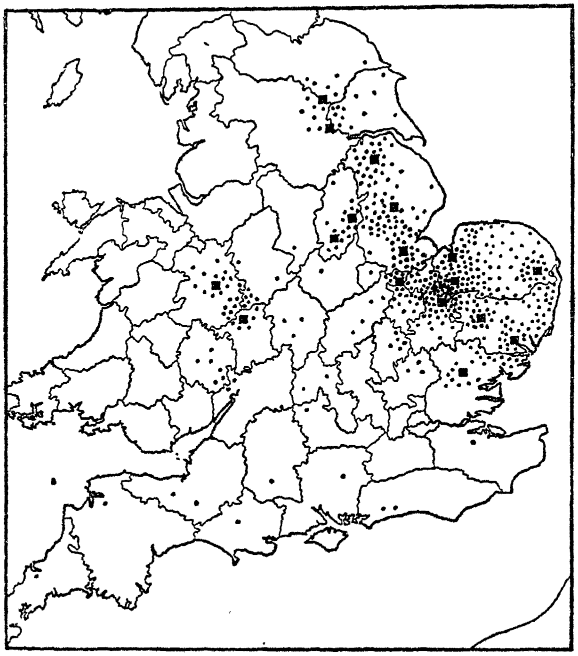


FIG. 102.—Sugar beet in England and Wales.

Each dot represents 500 acres of sugar beet in 1931–32 (approximately the same as average 1928–32). Each square represents a beet-sugar factory.

European beet-sugar production become that it roughly equalled the total world production of cane. Germany, Austria-Hungary, Denmark, and Holland were large exporters and supplied Great Britain with nearly two-thirds of her sugar. In 1913 Germany alone supplied nearly half a million tons—more than all the cane sugar used in England, and equivalent to 47 per cent. of the total imports. One of the most remarkable features in the history of sugar is the fact that the British Isles remained for so long without a home-grown

sugar industry. Efforts to establish factories in this country were made from 1909 onwards, plans for factories were arranged, and promises were extracted from farmers to grow the necessary beet. But the competition of bounty-fed cheap continental sugar in the open British market rendered all these schemes abortive. It is interesting to note, however, that the Cantley factory was built in 1912 before the War, very largely with Dutch capital, and thus the initiation of the modern industry in this country was mainly due to Dutch initiative. It was, of course, during the War that Britain felt the severe effects of not having a home-sugar industry. The beet-sugar producing countries of Europe were those that suffered most severely from the War; although this was of advantage to the cane-producing countries overseas, the shipping necessary to bring supplies of sugar to England could ill be spared. The normal imports of sugar into the British Isles had approached 2,000,000 tons, and during the War supplies had to be carefully rationed. In March, 1917, the Treasury sanctioned an advance to the British Sugar Beet Society of £125,000 as a loan for the development of the Kelham estate in Nottinghamshire, but for various reasons the factory was not ready to operate until March, 1921. In the meantime the Cantley factory, which had been disused during the War, was re-opened in 1920, and took beet which had been grown for the then uncompleted Kelham factory. In 1922 there was an approximate duty of 25*s*. 8*d*. on foreign sugars, 21*s*. $4\frac{2}{3}$*d*. on Empire sugars, and an excise duty on home-produced sugar of 19*s*. $5\frac{1}{3}$*d*. per cwt. Great assistance was given to the home industry on March 30, 1922, by the remission of the excise duty; but it was recognised that the high cost of duty of $2\frac{3}{4}$*d*. per lb. could not be maintained when the country settled down to the normal conditions after the War, so the British Sugar Subsidy Act was passed in March, 1925. It granted a subsidy on home-grown sugar for ten years, from and including the 1924–5 season, at the rate of 19*s*. 6*d*. per cwt. of sugar produced for the first four years, 13*s*. per cwt. for the next three years, and 6*s*. 6*d*. per cwt. for the remaining three years. The minimum beet price to be paid to farmers for the first four years was fixed at 44*s*. per ton of beet of $15\frac{1}{2}$ per cent. sugar content. The next table shows the remarkable growth of the industry under the subsidy. Difficulties arose in 1931 when the subsidy was supposed to be reduced from 13*s*. to 6*s*. 6*d*., the rate for the third and last period expiring September 30, 1934, owing to the extremely low prices then ruling. It was clear that the sugar-producing factories would be faced with a severe loss. The Government intervened, offering an advance of 1*s*. 3*d*. per cwt. on the first 300,000 cwt. produced by each factory. Most factories accepted and contracted at 38*s*. per ton of beet, $15\frac{1}{2}$ per cent. sugar content, with the farmers. But the lower prices and the delay caused by the negotiations resulted in a

PRODUCTION OF BEET SUGAR IN ENGLAND SINCE THE INCEPTION OF THE SUBSIDY [1]

Season	Acres	No. of factories	Production of sugar	Production of sugar per acre of beet
			cwt.	lb.
1924–25 . . .	22,441	3	478,308	2,387
1925–26 . . .	54,750	8	1,032,759	2,113
1926–27 . . .	125,814	12	3,003,933	2,674
1927–28 . . .	222,566	17	3,651,620	1,878
1928–29 . . .	175,734	18	3,874,664	2,469
1929–30 . . .	229,918	18	5,830,018	2,837
1930–31 . . .	347,257	17	8,454,574 [2]	2,727
1931–32 . . .	233,219	17	5,015,555	2,409
1932–33 . . .	255,648	17	—	—
1933–34 . . .	364,000	17	—	—
1934–35 . . .	396,348	17	11,668,860	3,297
1935–36 . . .	367,304	17	9,277,140	2,829

[1] *Agricultural Statistics*, 1931, Vol. LXVI, Part I, p. 15. H.M.S.O., 1932, *ibid.*, 1935.

[2] Including the equivalent of sugar produced at the Cupar factory in Scotland from beets grown in England.

Production 1939 and 1940 about 500,000 tons—sufficient for war-time consumption.

BEET-SUGAR FACTORIES IN ENGLAND [1]

Factory	Washed and topped beet delivered to factory		Rated beet slicing capacity per campaign of 100 days
	1930–31	1935–36	
	Tons	Tons	Tons
1. Allscott	140,909	142,000	85,000
2. Bardney	166,153	196,000	140,000
3. Brigg	112,361	145,000	110,000
4. Bury St. Edmunds .	324,529	368,000	225,000
5. Cantley	310,492	292,000	250,000
6. Colwick	129,966	132,000	120,000
7. Ely	300,068	268,000	250,000
8. Felstead	149,440	172,000	120,000
9. Ipswich	172,678	176,000	145,000
10. Kelham	96,394	91,000	100,000
11. Kidderminster . .	130,817	164,000	120,000
12. King's Lynn . . .	184,358	199,000	120,000
13. Peterborough . .	256,454	355,000	180,000
14. Poppleton . . .	123,653	171,000	120,000
15. Selby	113,458	124,000	100,000
16. Spalding	149,995	205,000	120,000
17. Wissington . . .	117,743	146,000	120,000
Total	2,989,468	3,346,306	2,425,000
Beets grown in England but delivered to Cupar in Scotland . . .	59,859		
Grand Total . .	3,049,327	3,346,306	2,425,000

[1] *Agricultural Statistics*, 1931, Vol. LXVI, Part I, p. 13. H.M.S.O., 1932. *Agricultural Statistics*, 1935. H.M.S.O., 1936.

great drop in acreage, and the number of growers decreased from 40,400 in 1930 to 32,300 in 1931. It is interesting to analyse the position in 1931, to see what progress has been made from the cultivation point of view. The average yield in that year was 7·1 tons per acre, which was poor compared with the 8·8 in 1930, and the 8·7 in 1929. But the sugar content was higher—17·3 per cent.—as against 16·7 per cent. in 1930, but 17·7 per cent. in 1929, despite a poor season. The conditions necessary for the cultivation of sugar beet agree in general with those required for other root crops. It requires well-drained fertile loamy soil, whilst a certain proportion of lime in the soil is essential. It is an annual plant raised from seed and sown in the spring. The whitish parsnip-like roots are ready for digging towards the autumn. The roots are washed and topped, and are then ready for delivery to the factory. The first operation there is the slicing of the beet or the cutting of it into thin shreds. These are immersed in warm water so that a liquid containing the sugar is formed. This liquid is then treated with lime, which has, broadly speaking, the effect of removing impurities. The purified juice is then boiled in closed vessels in order to remove some of the water, which means it is converted into a syrup. The syrup is then heated in vacuum pans away from the air, and this has the effect of causing little crystals of sugar to start forming in the mass of the syrup. After a period of rapid boiling there are immense numbers of tiny crystals of sugar floating about in the syrup. The whole now forms a thick, sticky mass. This mixture is then put into pans with very fine wire mesh walls ; the pans are then rotated very quickly indeed, perhaps at the rate of a thousand revolutions a minute, with the result that the liquid syrup flies away from the centre through the wire gauze and the sugar is left inside. This is in the condition of raw sugar, which has to be refined for the white sugar of commerce. The liquid or heavy syrup which is thrown off when the crystals are formed is called molasses. The residue of pulp from the beet applied either direct or as offal from the cattle fed on it makes excellent manure, and there is a steadily increasing demand in this country for wet pulp mixed with molasses, both a palatable and a valuable cattle food. The two difficulties in the establishment or prosecution of the beet-sugar industry remain to be mentioned. One is the need for close co-operation between the factories and the farmers ; the supply of sugar beet must be assured from year to year. The second difficulty is that the sugar beet is a heavy, bulky commodity, and transport costs are naturally serious. It is almost useless, therefore, for the farmer to grow sugar beet unless he has adequate transport facilities at low rates, and can thus supply a factory not too far distant. At the same time beet must be grown in rotation with other crops, and the amount of land immediately surrounding any factory, however large, must therefore

be strictly limited. These factors tend therefore to limit distinctly the size of the factories which are possible in this country.

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J. W. Page : *Geography,* Vol. XV, Dec., 1930, 661–64.

The Canning Industry.—One of the most spectacular developments in British industry in the last few years has been the phenomenal rise of the canning industry. There is no official return of output, but the following table gives an estimate of the output of canned fruit and vegetables in number of cans in the last few years. It will be seen that in five years the output increased tenfold, from about 10 million cans to over 100 million cans. Towards the close of 1932 there were nearly 60 factories (ten of which had come into production during that year) employing the modern mass-production automatic machinery. For some time there was a prejudice amongst the British public against tinned and canned goods generally, and there are even now some packers who remove fruit and vegetables from cans received from abroad, repacking them in glass jars for the benefit of the fastidious British taste. But it is safe to say that the excellent record of tinned fruits during the War and the disappearance of lead, tin, and ptomaine poisoning which could be traced to tinned goods almost succeeded in removing the last traces of these prejudices. Huge quantities of tinned fruit of tropical and sub-tropical origin not obtainable in this country are imported and used, for example, pineapples, peaches, apricots, etc. Despite the phenomenal increase in output of British canned fruit and vegetables, there is no sign of diminution of imports of such exotic fruits. Indeed, the import of foreign tinned fruit for 1931, amounting to 150,000 tons, valued at £5½ million sterling, was easily a record. Pineapples represented 40,000 tons of this total and were the most important, but were followed closely by peaches and pears with 37,000 tons each. Of the pineapple imports 90 per cent. came from Empire sources, particularly from Malaya ; but 90 per cent. of the peaches, pears, and apricots came from foreign countries, mainly the United States of America (California). Indeed, the United States alone sent 94,400 tons of fruit, or 25,000 tons more than in the previous year. This increase of 25,000 tons was equal to the whole of the output of canned fruit in Britain and serves as an illustration of the enormous field that is still open at home for British fruits. There is, in addition, an almost limitless overseas market which may be captured by British growers and British canners ; and already there is a small export

trade, though it amounted in 1931 to only 360 tons. There is still a large import of canned vegetables which might well be produced at home. For example, in 1931 between 3,000 and 4,000 tons of canned peas came from the Continent and the United States, nearly 1,000 tons of asparagus from the United States, and 5,000 tons of baked beans. In the past one of the great difficulties of the British farmer growing fruit and vegetables for market has been the short-

Estimate of Output of British Canned Fruit and Vegetables (Cans)

1913	negligible	1929	16,340,000
1924, 1925	very small	1930	34,200,000
		1931	83,000,000
1926	7,000,000	1932	100,000,000
1927	7,840,000	1934	120,000,000 from 76 factories
1928	7,930,000		

ness of the English season. Thus too often a good season means a good season for everybody, a glut of fruit and vegetables and very low prices. Even before the War, to give a personal example, the writer remembers being unable to get $\frac{3}{4}$*d.* per lb. for first quality English plums picked and delivered to market, and alternately being unable to secure an offer at all for the fruit growing on the trees. Obviously, canning supplies a way of dealing with such a glut; but this is at once the strength and the danger of the new industry, its opportunity and its difficulty. Provided that the area of production is near the cannery, the fruit can be picked when the weather is suitable and taken to the cannery and the operation of canning completed within 24 hours. The operation is within the scope of the small grower because there are on the market small canning machines which can be worked by manual labour. The great danger is that sufficient care will not be taken in the grading of the fruit. Maintenance of quality is essential for the prosperity of the industry. Similarly, it is undesirable for fruit to be brought from a distance and to suffer the disadvantages of carriage before being canned. The control provided by the National Mark system is thus one which can be a particular benefit to the industry. The second great difficulty in the economic working of the canning industry is that the season of production is very short. Broadly speaking, fruit and vegetables are only available for canning in this climate for about four months—June, July, August, and September. To run a factory and to secure an adequate labour supply for four months out of the twelve is obviously a difficulty. From what has been said it is plain that the factory must be built near the areas of production, and thus the British canning factories of importance are those situated in the fertile lands of East Anglia, such as Fenland, and Norfolk and Suffolk. If a factory can be built at the same time near the seaboard, for example, at Ipswich, it may be possible to combine with the fruit and vegetable canning the canning of fish, so as to occupy the

machinery for a greater part of the year. Even so it is difficult to extend the period of operation of the factory for more than six months of the year. A possible solution has recently been offered in the canning of roast chicken, chicken in aspic, and other poultry. It may be mentioned that the tinplate necessary for the cans is produced in South Wales (see Chapter XVIII), so that the development of this industry is having a favourable reaction on Welsh tinplate trade. The Metal Box Co., which is an association of the more important packing firms of the country, turned out in 1932 more than 100 million open cans for fruit and vegetables. Until the end of 1931 the closing and other machines required in the industry were an American monopoly, but they are now being made in Britain.

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The Brewing Industry.—In view of the fact that a large proportion of the home-grown supplies of barley is destined for manufacture into beer, and in view of the fact also that the growing of hops is for the same purpose, brewing may well be classed as an agricultural industry. In the manufacture of beer the barley is first malted, then ground into coarse meal, and the first process in the actual making of the beer is the mixing of this meal, or malt, with warm water. The mixing is carried out very thoroughly in what are called mash-tuns, the malt and water being thoroughly mixed by mechanical stirrers. Much of the goodness of the malt passes into the liquid and the whole is called wort. This liquid is strained off from what is left, the remains of the barley are dried and sold to the farmers, forming a valuable cattle food. From about 11 cwt. of barley about 3 cwt. are thus returned to the farmer for use in feeding his cattle. In many ways this cattle cake is actually a better food than the original barley itself. The wort is then pumped into another part of the brewery and passes into the coppers. There two or three lbs. of hops to a barrel of beer are added and the whole is boiled for about an hour and a half or two hours. The wort has now derived a bitterish flavour from the hops and has to be strained off from the remains of the hops. It passes into a "cooler" so that it comes out at about the ordinary temperature of a cool summer day, that is from 56° to 60° F. In large fermenting vessels into which the wort is now conducted yeast is added, and changes the sugar of the wort into alcohol. When the yeast has done its work it rises to the surface and the scum so formed is cleaned off. The beer is now ready for running into the great storage vats from which it can be run off into barrels as required.

The annual consumption of beer in the British Isles is between 25 and 30 million barrels, a barrel containing 32 gallons or 256 pints. Very roughly this is about 130 pints per head of population per year. In the old days the brewing of beer used to be carried out very largely in small farmhouses, but it has become more and more concentrated in the large breweries. Even the smaller breweries are disappearing. One reason for this is that the exact character of the water used in the malting process is very important. The best results are obtained from water which possesses a considerable permanent hardness due to the presence in solution of the salt calcium sulphate. The well water from the Keuper Marls at Burton-on-Trent is of this character and is therefore particularly suitable. The brewing industry of that town is no doubt largely a result of this. Manchester, Warrington, Chester and Liverpool are other brewing centres situated on the Trias, and on the Trias belt east of the Pennines there is Tadcaster. In some cases the salt is added artificially to the water—the process commonly known as "burtonising" the water. One of the largest breweries in the world is in Dublin where Guinness's stout is made. For further details, see under Dublin (p. 620).

Vinegar is made from malt in very much the same way, but there is an additional process. The alcoholic liquid, not very dissimilar from beer, is run into pans which contain beechwood shavings that have been soaked in old vinegar. There are organisms in these which set up a change by which the alcohol is converted into the sour acetic acid of the vinegar. Hence the expression "pure malt vinegar."

Distilling.—Despite the decrease in consumption which is due to the high excise duties and changes in popular taste, whisky perhaps may still be regarded as the natural drink of Scotland and Ireland as beer is of England. In 1913–14 nearly 27 million proof gallons were consumed in the British Isles (17·9 in England and Wales, 6·2 in Scotland, and 2·3 in Ireland), this representing 0·5 proof gallon per head of population. By 1926–27 the total had fallen to less than 12 million gallons (8·4 in England and Wales, 3·1 in Scotland), representing only about 0·24 proof gallon per head of population. Indeed, many of the hundred odd distilleries still remaining depend entirely for their prosperity on the export trade. There are three stages in the manufacture of whisky: malting and mashing the barley, or the preparation of the wort, as in the manufacture of beer, the fermentation of the wort to produce the wash, and the separation of the spirit from the wash by means of distillation. For Scotch whisky barley is practically the only material used. In Irish whisky, barley, oats, wheat and rye are generally mixed. The distillation is carried out in two main types of stills; there are the old-fashioned pot-stills, which consist of a vessel in

which the wash is boiled and to which is attached a pipe to carry the vaporised ingredients of the wash to a condenser, where the distilled liquid falls into a receiver. The heat is supplied directly from a fire, but the distinctive flavour of pot-still whisky has been said with doubtful truth to be very largely due to the use of peaty or other special fuels in the preparation of the malt itself. In the patent stills of the large distilleries those flavours tend to be absent from the whisky, which is more standardised. In Scotland, Banffshire is a focus of the industry.

THE NATION'S FOOD

According to Sir John Russell the nation's total food bill for the average of the four years 1924–25 to 1927–28 was approximately £639,000,000 annually. Of this 39·3 per cent. was produced at home, the Empire supplied 21·6 per cent., foreign countries supplied 39·1 per cent. The table given below shows the total food supplies per head of population in Great Britain and is taken from Sir John Russell's book.

TOTAL FOOD SUPPLIES PER HEAD OF POPULATION, GREAT BRITAIN [1]

	Average supply per head of population per annum		Proportion of estimated total value (including Excise and Customs Duties)	
	Pre-war [2]	Post-war [3]	Pre-war	Post-war
	lb.	lb.	Per cent.	Per cent.
Wheat and flour	208·0	207·0	12·2	10·7
Meat (including rabbits and lard)	144·9	147·1	38·6	33·7
Beef and Veal	*69·4*	*71·4*	—	—
Pig meat and lard	*42·8*	*46·8*	—	—
Mutton and lamb	*28·4*	*26·2*	—	—
Fish	43·7	41·9	3·3	3·8
Poultry	3·9	3·7		
	Number	Number	6·6	6·8
Eggs	111·0[4]	116·0[4]		
Milk:	Gallons	Gallons		
Fresh [5]	19·5	20·0		
	lb.	lb.		
Condensed and powder	*	8·1	21·5	21·7
Butter	15·8	15·4		
Cheese	8·7	9·5		
Margarine	5·0	12·4		
Potatoes	189·0	192·0	4·8	6·7
Other vegetables	*	*		
Fruit and nuts (all kinds)	74·0	101·0	5·7	8·3
Sugar	80·0[6]	86·0[6]	7·3	8·3
Cocoa	1·1[6]	2·6[6]		

[1] From *The Agricultural Output and the Food Supplies of Great Britain*, 1929.
[2] 1907. [3] Average of 1924–25 to 1927–28.
[4] Eggs in shell only, *i.e.* not including imported eggs not in shell.
[5] Including cream consumed in farm households.
[6] Fuller details given in the Annual Reports of the Customs and Excise Department. * Not available.

PROPORTIONS OF GREAT BRITAIN'S FOOD SUPPLIES FROM VARIOUS SOURCES [1]

	Pre-war period			Post-war period		
	Home production	Net imports from		Home Production	Net imports from	
		British Empire	Foreign countries		British Empire	Foreign countries
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Foodstuffs normally produced in Great Britain						
Wheat and flour	20·0	27·9	52·1	15·0	43·4	41·6
Meat (including rabbits and lard)	52·0	17·0	31·0	44·3[2]	17·2	38·5
Poultry and eggs . . .	45·7	17·1	37·2	49·8	13·7	36·5
Dairy produce	47·6	21·6	30·8	48·7	25·4	25·9
Potatoes and other vegetables	72·3	7·7	20·0	70·3	7·2	22·5
Fruit, raw (small and orchard)	57·7	14·1	28·2	44·0	17·6	38·4
Total of above . . .	47·2	19·1	33·7	44·1	2·5	34·4
Fish	78·5	8·4	13·1	61·3	7·7	31·0
Total, including fish . .	48·4	18·7	32·9	44·9	20·9	34·2
Estimated value, £ million .	136·2	52·6	92·8	248·9	116·2	189·9
Total, including foods imported and foods not given above as they are not normally produced in this country, £ million		314·5			639·0	

Taking consumption per head, this table shows the interesting fact that there has been comparatively little change in the *per capita* consumption of the essential foods, such as bread and meat. There has unfortunately been a decrease in the use of that valuable food, fish, which is scarcely balanced by a small apparent rise in the consumption of eggs. The most notable increases are in the case of commodities which either were not readily available in pre-war years in the same way that they are to-day, or commodities the use of which has been encouraged by advertisement. Thus the consumption of fruit has increased, doubtless due to the larger supplies of bananas, oranges, apples, and soft fruit now readily available throughout the year. An interesting feature is the large increase in the consumption of margarine. The last two columns of the above table are interesting because they show that roughly half the money spent on food in this country is spent on bread and meat, nearly a quarter on milk and fats. Again, the small percentage represented by fish is noteworthy. The next table, taken from the same book, shows the

[1] Compiled from *The Agricultural Output and the Food Supplies of Great Britain*, Ministry of Agriculture and Fisheries, 1929. (From *The Farm and the Nation.*)

[2] In 1936 the City Central Market Committee estimated that the home production accounted for only 25·8 per cent. of the meat consumed by 9,000,000 Londoners.

proportion of Britain's supplies from various sources. Taking some of the more important items in order, the change in origin of our wheat and wheat-flour is particularly noteworthy. Before the War huge quantities came from the United States, but now Canada is easily the chief source, followed by the United States, the Argentine and Australia, these countries sending on an average over 90 per cent. of the total. The pre-war supplies from Russia have, of course, almost disappeared. Of other grains imported maize is important as food for live stock, and 35 million cwt. are imported annually, five-sevenths coming from the Argentine, one-seventh from British South Africa, and the remainder from Rumania and the United States. We import annually about 30 million cwt. of meat, of which over 12 million is chilled beef from the Argentine. It is noteworthy that the import exceeds the home supply, only about 43 per cent. of the beef consumed being produced in the British Isles. Five million cwt., mainly of mutton and lamb, come from New Zealand and Australia, whilst the five million cwt. of meat from Denmark is mainly bacon. Other supplies in smaller quantity come from the United States, Uruguay, the Netherlands, and Canada; whilst a feature of importance has been the recent rise in the import of bacon from Poland. Over half the eggs used in this country are produced at home, but the import reaches the stupendous figure of 3,000,000,000. When stated as 26,000 thousands of great hundreds it does sound as much. Half this huge quantity comes from Denmark and Holland,[2] rather less than a fifth from Eire, and a tenth each from Poland and Belgium. Of recent years large supplies have been coming from Australia and South Africa, and there has for many years been a huge import from China, which are eggs out of their shell, sealed in tins, and used mainly in confectionery. Changes in world communications have been responsible for large quantities of poultry now coming from Australia and South Africa, whereas until recently the only country sending poultry to Britain was Eire. Turning to dairy produce there is practically no import of fresh milk, but an increasing quantity of dried and condensed milk, amounting to about 8 lbs. per head per annum, corresponding to 2·4 gallons of milk. The advantages of a fresh milk [1] supply are obvious, hence the desirability of concentrating on the production of this commodity in the country itself. Forty per cent. of the butter imports come from the Empire, from New Zealand, Australia, and Eire. Denmark send us one-third of our total supply and the Argentine is another important source. New Zealand, easily first, and Canada send us together 60 per cent. of our imports of cheese, the other countries being Holland and Italy. The details for vegetables and fresh fruit really deserve a

[1] "The one and only perfect and complete food known to man." See Prof. H. E. Armstrong, *Nature*, 29th April, 1933.

[2] **All statements on this page refer to conditions before the outbreak of war in 1939.**

chapter to themselves, because they illustrate in a remarkable way what can be done with improved methods of transport, specially constructed ships with special refrigerating machinery extending the markets for a commodity. And it is to be feared that improvements in methods of canning abroad, particularly in North America, aimed a blow at British market gardening from which that industry is only just beginning to recover, despite the fact that in quality our vegetables can compete satisfactorily with anything imported which is grown under similar climatic conditions.

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See also References following the next chapters.

CHAPTER XI

THE AGRICULTURAL REGIONS OF SCOTLAND

SCOTLAND has been divided into a number of simple agricultural regions by H. J. Wood,[1] and his divisions will be used in the following account. Taking the whole of Scotland it is remarkable that 98·7 per cent. of the total area occupied by crops and grass is represented by permanent grass, rotation grass, oats, barley, wheat,

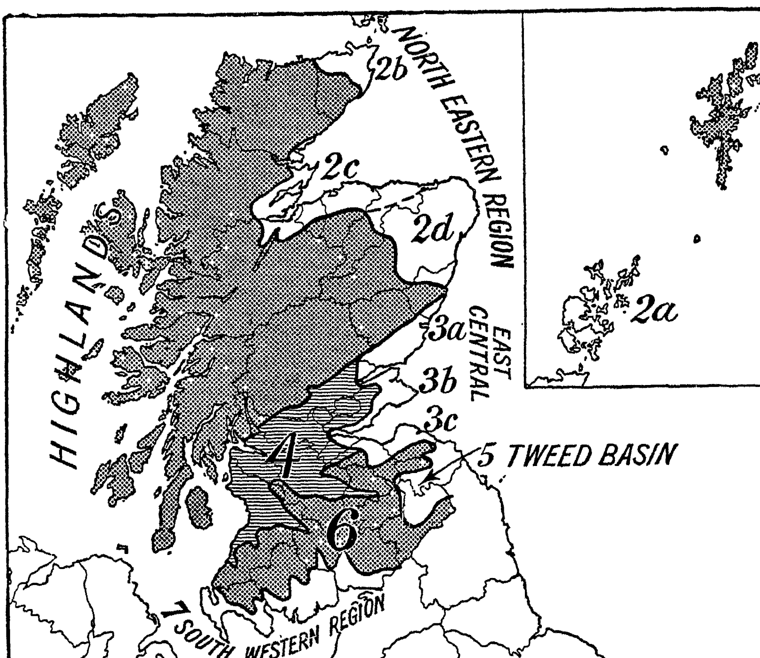


FIG. 103.—The Agricultural Regions of Scotland. (*After H. J. Wood.*) For explanation, see text.

turnips, and potatoes. The relative distribution of these crops, therefore, gives a key to the farming economy in the various regions and in some cases to variations within them.

[1] *An Agricultural Atlas of Scotland.* George Gill & Sons, 1931.

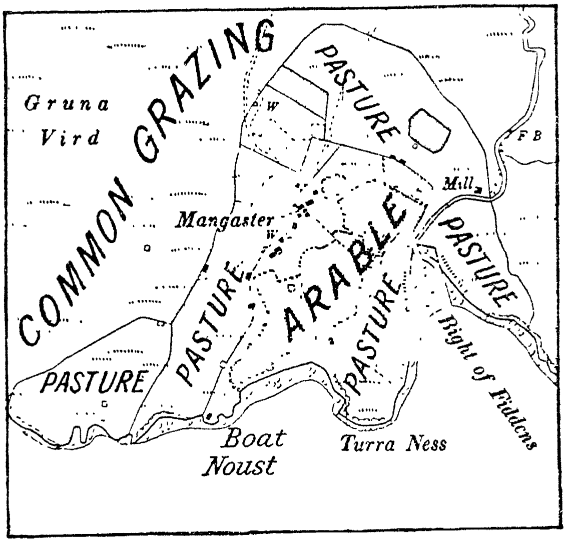


FIG. 104.—Map of a typical croft (Shetland Islands).

Notice the water supply (by wells) and the two approaches to the croft—one by land by rough tracks, the other by sea (the boat-house or boat noust has been marked). The corn grown on the patch of arable land was formerly ground by a water-mill (marked)—but most of these mills are now disused. Scale of map, 6 inches to the mile (Based on the Ordnance Survey map by permission).

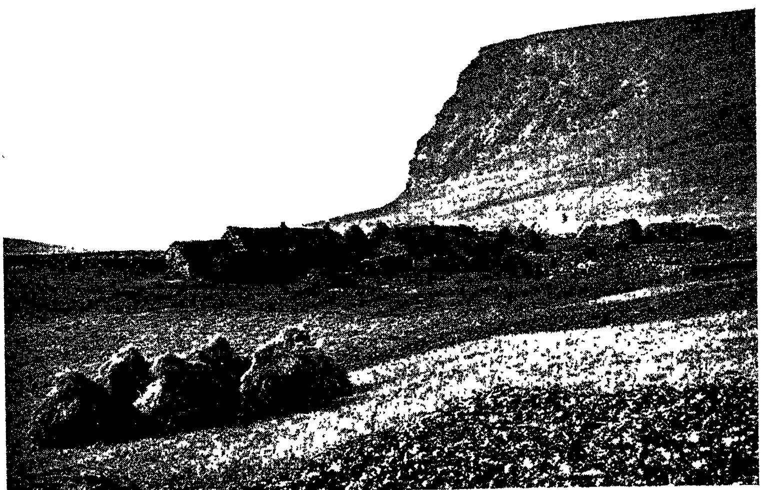


FIG. 105.—Photograph of a crofting settlement in Shetland, taken in 1875.

This large and flourishing settlement has now entirely disappeared—the site is occupied by moorland and is marked only by a few heaps of stones. This is typical of rural depopulation in many parts of the Highlands and islands of Scotland.

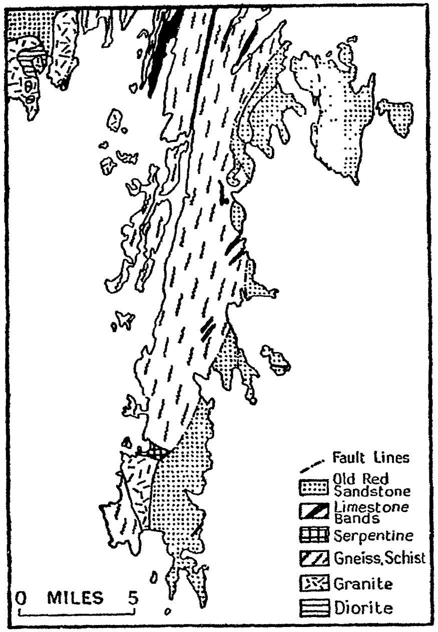


FIG. 106.—The geology of South Shetland.

Fair Isle consists entirely of Old Red Sandstone. Most of the settled land shown in Fig. 108 is on the Old Red Sandstone or on limestone bands.

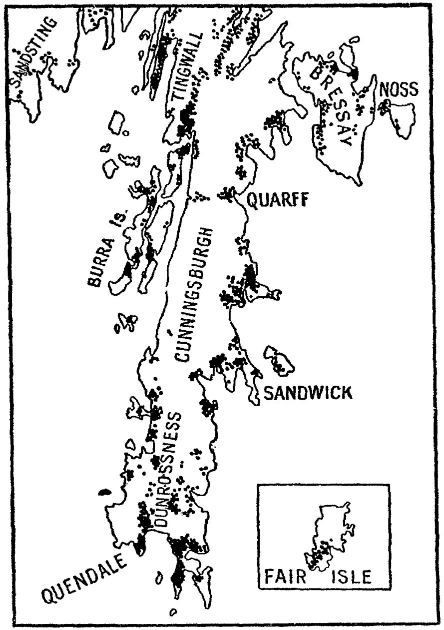


FIG. 107.—Scandinavian settlements in South Shetland.

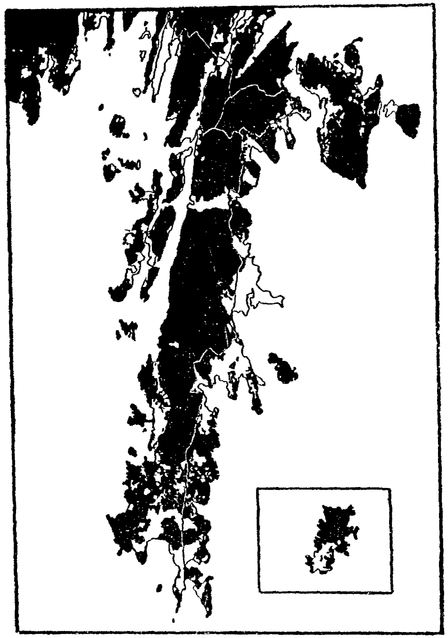


FIG. 108.—Present-day settlement in South Shetland. The black area is moorland: the blank areas settled or improved land.

Diagrams to illustrate the influence of soil on settlement in the Shetland Islands—diagrams prepared by A. C. O'Dell.

1. The Highlands and the Western Isles

The Highlands of Scotland form a region well marked from both the physical and agricultural points of view and the most extensive in Scotland. The south-eastern boundary follows in general the line of the Highland boundary fault; only here and there are valleys which open out on to the fringing corridor of lowland. To the east the boundary with the north-eastern agricultural region is not a sharp one, highland conditions disappear gradually as one passes eastwards. Although there are naturally variations within this huge area it is generally true to say that agriculture is the primary occupation, supplemented by fishing along the coastal fringes. The Shetland Islands, with their dependence upon both fishing and agriculture, are really part of the same region. The hard old rocks, resistant to erosion, from which the great Ice Age swept much of the previously accumulated soil, have combined with climatic conditions to leave but few and small areas suitable for agricultural settlement. High rainfall, humid conditions, cool summers liable to be rainy and a lack of sunshine result in an abundance of surface water and wide areas of bog and marsh. Drainage is difficult, and even when it has been carried out the wide spread of acid peat soils militates against cultivation. Limestone is but rarely available locally to ameliorate the acidity. Generally as one goes eastwards conditions become slightly more favourable with the lowering of the rainfall. In the poorer western lands the crofting system prevails, but rural depopulation has long been the rule; men of Highland stock gravitate towards the more favoured agricultural lowlands, or to urban centres, and to foreign countries where better opportunities await them. Much of the rough grazing is given over to sheep, much to deer and grouse, but there are still huge areas which have practically no use at all.

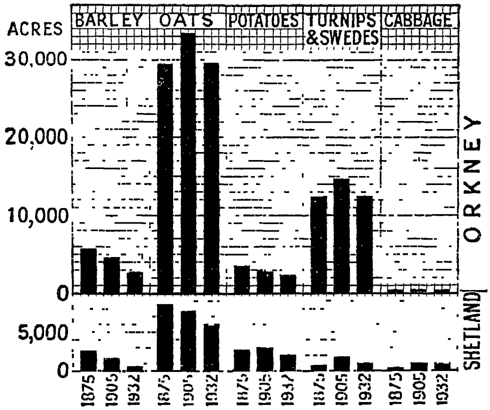


FIG. 109.—Diagram contrasting the crops of Orkney and Shetland—illustrating the contrast between the north-eastern Region of Scotland (of which Orkney is part) and the Highlands proper (of which Shetland is part).

Diagram prepared by A. C. O'Dell.

The drier or wider glens, especially those of the Tay system towards the east, and tracts along the western coastal fringe, are the most useful for settlement. Permanent grass and a few small crops of oats and turnips are here to be found. The raising of cattle is the chief economic aim of these Highland farms, young surplus animals being sold locally or going to more favoured or more populous areas for fattening. The number of cattle is high per acre of improved pasture; for whereas the average in Scotland as a whole is between 20 and 30 head per 100 acres, in much of the Highland region it rises to 40 and in some cases even to over 100. Amongst interesting local variations the large proportion of improved land under potatoes in the Outer Hebrides near Stornoway may be noted, as suggesting a comparison with western Ireland.

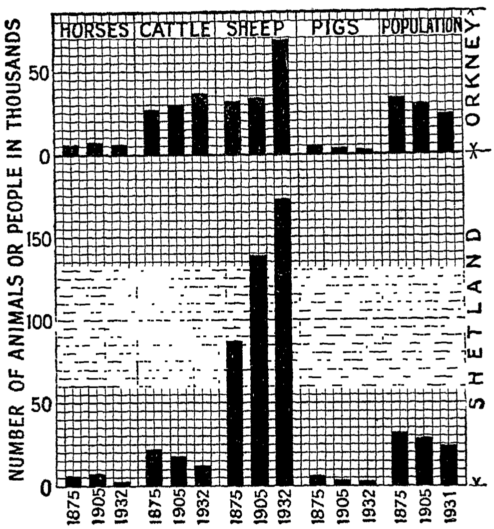


FIG. 110.—Diagram contrasting the animals and population in Orkney and Shetland.
Diagram prepared by A. C. O'Dell.

2. The North-Eastern Region

This is a coastal region of varying width and really may be described as falling into four parts:

(*a*) The Orkney Islands;

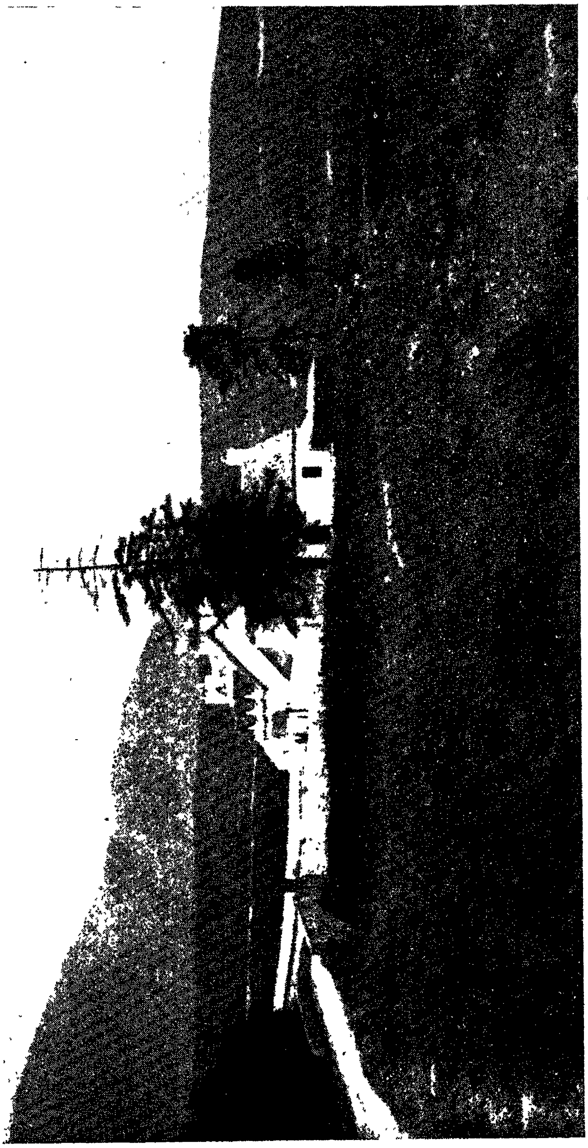
(*b*) The north-eastern part of Caithness, remarkable for its wide open stretches of arable land and absence of trees;

(*c*) The Moray Firth lands;

(*d*) The Buchan Plateau or the "shoulder" of Aberdeenshire.

In the three northern tracts the area is, in the main, underlaid by Old Red Sandstone, and in Aberdeenshire by granitic and metamorphic rocks, but there is in general a covering of drift, and the moderately acid soils are suited to the dominant crops—rotation grass, oats, and turnips. The summers are too cool for the ripening of wheat; but in the favoured areas, particularly

around Moray Firth and along the coastal strip from Moray Firth to the shoulder of Aberdeenshire, barley is of considerable im-



[*Photo: L. D. Stamp.*

FIG. 111.—Kingshouse, near the head of Glencoe.

Typical of the old hostelries found frequently in the loneliest and wildest parts of the Highlands and suggesting the greatest industry of the region—sport—for these hotels are used mainly by sportsmen.

portance, not, however, in the Orkney Islands or Caithness. It is remarkable that there is extremely little permanent grass. There is extensive pasturage of sheep on the fringes of the moorlands,

[*Photo : L. D. Stamp.*

FIG. 112.—The Castle Rock, Edinburgh.

View from Prince's Street showing the precipitous western face of the old volcanic neck on which the castle of Edinburgh was built and which formed the nucleus of the original settlement.

almost absent; turnips play a smaller part in farm economy here than they do in the east of Scotland, whilst potato production on a large scale is limited to certain localities. This is pre-eminently a cattle-rearing area, the home of the famous Ayrshire cattle. The raised beaches along the coast of Ayrshire with their sandy soils and mild spring weather have given rise to quite a specialised early potato industry centred on the town of Girvan. The demand from the towns obviously exercises an influence here as it does noticeably on the main centres of the dairying industry. As Dr. Wood says of the western area, "it is a tributary of Glasgow, the economic tentacles of which grip the whole of the west-central area with varying strength relative to distance from the capital of the west." The old-established orchard area of Lanark is noteworthy.

5. The Tweed Basin

The agricultural region of the Tweed Basin is limited by a semicircle of moorland, and indeed the edge of the moor may be said to form the limit of the region. Throughout the whole permanent and rotation grass are of almost equal importance. Oats are, of course, the leading cereal crop, but turnips, winter food for sheep, are everywhere important, as one would expect in a region where upland and lowland are integrally linked in a pastoral farming régime. Potatoes are unimportant. Towards the mouth of the Tweed there is a sub-region, the Merse of Berwick, which is distinctive in that it has a considerable acreage under wheat and still more under barley. It will be found that this area extends into the northern part of Northumberland. The Tweed Basin includes much of the "Scott country" and is remarkable in many ways for the English appearance of its scenery, with its hedges and numerous scattered trees giving a well-wooded appearance. Cattle are numerous in the lower-lying districts of mixed farming, but the district is unique in the whole of Scotland, and indeed in the British Isles, for the number of sheep it carries. In the upper basin, in Tweeddale, Ettrickdale, Teviotdale, and Lauderdale, the density of the sheep population is phenomenal, and large sheep farms are characteristic. The poorer sheep pastures support the black-faced sheep, the better pastures at lower levels the Cheviots, whilst an improvement of breeds on lowland farms has been carried out by crossing with Southdown and Leicester. There is, of course, a winter movement from the higher land to the lowlands. For an account of the woollen industry, see p. 468.

6. The Southern Upland Region

The greater part of this region is occupied by moorland, but the Southern Uplands differ from the Highlands in the gentler relief of the hills and in the better pasture which they afford, and hence

the greater density of the sheep population. The Southern Upland region is essentially the domain of the black-faced sheep. Settlements, so far as they exist, are located in the valleys and on the river terraces of these valleys there are fields, usually of permanent grass, sometimes of sown grass, and still less frequently of oats and turnips. Most of the larger valleys, of course, afford important routeways.

7. The South-western Region

This lowland region borders the Southern Uplands from the head of Solway Firth on the east to Wigtownshire on the west. On the east are the important dales breaking into the Southern Uplands, in the centre is the coastal tract or the Rhinns of Galloway. The region has a relatively heavy rainfall of up to 50 inches and cloudiness is a characteristic feature. Wheat and barley are little grown under such climatic conditions; oats form the principal crop, but the greater part of the land is under permanent grass or sown grass. It is only towards the drier east, for example in Annandale, that one gets a considerable proportion of turnips. The whole region has large numbers of cattle, especially dairy cattle, and usually Ayrshires. The mild climate permits the cattle to be kept in the open all the year round. Quantities of milk are sent to the towns south of the border and there is also an extensive manufacture of butter and cheese. There is a tendency, but not so marked as in Ayrshire, to lay down under grass for as much as eight or ten or even more years land which has been ploughed, and then to plough it for two years before laying down again to grass. It is always difficult to decide whether this is strictly rotation grass or permanent grass.

The upper limit of cultivation in Scotland varies greatly from one part of the country to another, and the factors which determine it are worthy of more attention than they have received. A humid atmosphere and soggy ground seem responsible for a very low limit in Wigtownshire (usually observed at a little over 200 feet), increasing in the dales and the drier east.

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CHAPTER XII

THE AGRICULTURAL REGIONS OF ENGLAND AND WALES

It would be hard to find an area anywhere in the world of comparable size where wide variation in types of soil consequent upon complicated geological structure, considerable variation in topography, and by no means unimportant differences in climate between west and east, south and north combine to give such a wide variation in agricultural conditions as in Britain. It may even be foolish to talk of the economic condition of British farming or of the British farmer, or to put forward sweeping proposals for the amelioration of present conditions without due regard to local, one might even say parochial, conditions. Because of the immense importance of this aspect of British agriculture, an attempt is made in this chapter to divide England and Wales into broad agricultural regions, and in some cases to suggest a tentative division into sub-regions. It will be noticed at once that these agricultural regions show little or no relationship to administrative divisions. Thus statistics arranged on a county basis can be very misleading in forming comparisons. Even the statistics collected by the Ministry of Agriculture and Fisheries on a parish basis and not published are frequently insufficient in detail. It is a well-known fact that a large proportion of English parishes owe their peculiar form (witness the long narrow parishes stretching from the chalk downs of the north of Surrey to the heart of the Weald) to the necessity [1] of sharing fairly between neighbouring parishes good land and poor, upland pasture and lowland pasture, suitable for sheep and cattle respectively, light friable loamy land for tillage and heavy clay land unsuitable for crops.[2]

The broad twofold division into a Highland Zone in the north and west and a Lowland Zone in the south and east, which has already been repeatedly used, affords also a broad general distinction

[1] But see the comments on p. 558.

[2] It is one of the main objectives of the Land Utilisation Survey of Britain, by recording the use made at the present day of every field in Britain, to provide for the first time an exact record of the distribution of different types of utilisation. It will then be possible to evaluate the relative importance of the various factors, such as soil, elevation, aspect, drainage, accessibility, and certain economic factors in determining the type of farming which prevails in any given area. When the records of the Survey have been fully studied it is proposed to publish an account of the agricultural regions of Britain.

of Britain into two agricultural zones. The older rocks to the north and west with their comparatively poor siliceous soils are on the whole upland regions enjoying a comparatively heavy rainfall—in almost all areas over 30 inches. Soil and climate combine to

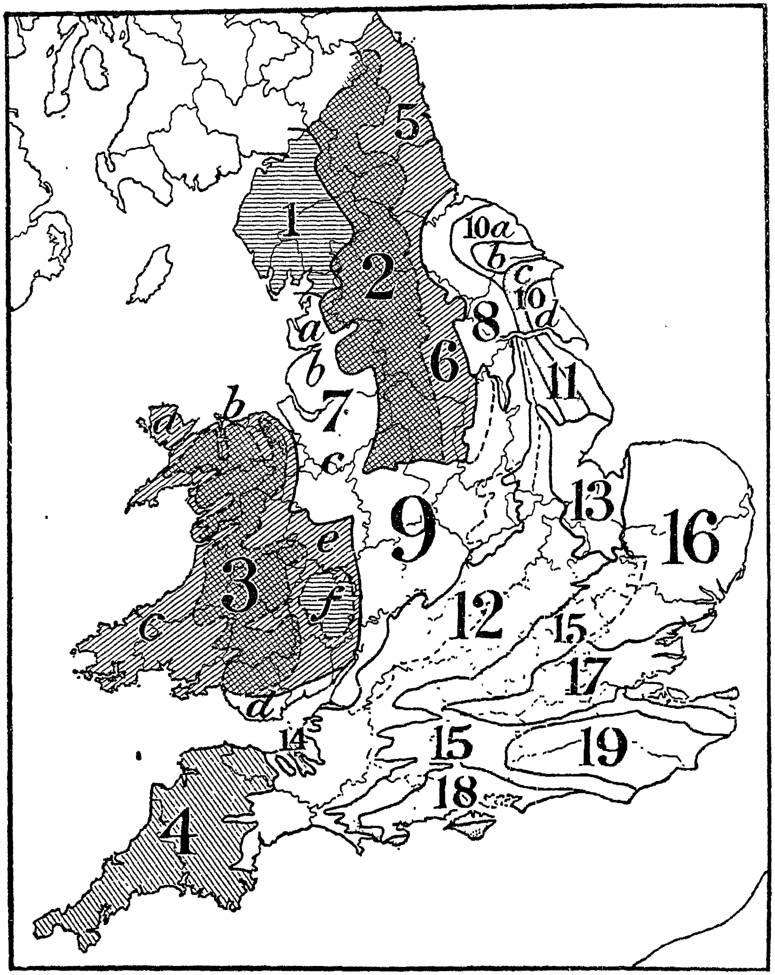

FIG. 113.—The Agricultural Regions of England and Wales.
The regions are numbered to correspond with the descriptions given in the text.

render arable farming of secondary importance in nearly all areas. Where arable farming is carried on the crops which can be grown, as already noted, are limited. The lands to the south and east, on the other hand, with their younger softer rocks have soils on the whole more suitable for agriculture. Over the Midlands and east

the rainfall tends to be almost everywhere less than 30 inches, and though in southern England south of a line joining the Thames and Severn most of the higher ridges have a rainfall of over that figure, nowhere does one find the heavy annual falls characteristic of so much of the north and west. Even so there is a broad general distinction between the damper lowland cattle-farming tracts and the drier eastern predominantly arable-farming tracts.

In general, the cultivable and habitable tracts of the Highland Zone form islands of varying size and extent in a sea of moorland and hill pastures : in the Lowland Zone it is the less fertile uplands which form islands in a sea of cultivable and habitable land.

A. Regions of the Highland Zone

1. The Lake District or Cumbria

This region, consisting as it does of a central knot of mountainous country with a very heavy rainfall and a surrounding ring of lowlands (broken only in the south-east), exhibits considerable differences from the agricultural point of view ; but because of the migration of animals (particularly sheep) between one region and another, according to season, there is a certain essential unity in the whole tract. Broadly it consists of four parts :

(*a*) *The Central Mass*, with rough hill pastures supporting fell sheep in the summer only and cattle on the damper pastures of the broader valleys. Here is seen to perfection the northern shepherd with his wonderful care of the sheep and his amazingly clever sheep-dogs.

(*b*) *The Eden Valley* on the lee side of the mountains, with a comparatively fertile red soil and a rainfall falling in places to as low as 30 inches. Thus there is a considerable proportion of arable land, but owing to the northern situation no wheat and no barley are grown, the leading crops being rotation grasses, turnips and swedes—obviously grown for the feeding of the large number of cattle (beef cattle more important than dairy cattle).

(*c*) *The Solway Plain*, where conditions are similar, large numbers of the fell sheep being driven to the pastures for feeding in the winter months when the fell pastures are snow covered.

(*d*) *The south-western and southern fringe*, undulating land more exposed to rain-bearing winds, and hence with a heavier rainfall and much less arable farming. There is much woodland and much permanent grass, and cattle rearing takes the leading place.

2. The Pennines

The eastern slopes of the Pennines are reserved for special consideration. The main mass of the Pennine uplands is of course

occupied by moorland or rough-hill pasture. Considerable tracts, especially of the Millstone Grit areas of the Pennines, are "reserved" as gathering grounds for water supplies of the large towns on the flanks of the Uplands (see Fig. 67), and here both animals and human inhabitants are few. Elsewhere sheep are almost the only tenants, though on the lower slopes they tend to share the pastures with limited numbers of beef cattle. As in all the less accessible pastures of the Highland Zone—cf. Wales—there is often extensive cattle breeding, the animals being sold to lowland farmers for fattening.

[*Photo : L. D. Stamp.*

FIG. 114.—Limestone pastures.

On the southern Pennines, at 1,100 feet, near Buxton. Notice the three black sheep.

3. Wales and the Welsh Borderland

Agriculturally the Welsh massif consists of a great core of moorland or rough-hill pasture and a surrounding fringe of land of greater agricultural utility. The central core of rough-hill pastures occupies an irregular area, but covers in all at least 2 million acres compared with a total for Wales of 5 million acres. Almost the only tenants of these hill pastures are the Welsh mountain sheep, and they can only be pastured there for comparatively short periods in the spring and early summer. The surrounding fringe may be divided as follows :

(*a*) *Anglesey.*—This island, with its low surface and its rainfall averaging just below or just above 40 inches, has remarkably little rough pasture, but a very high proportion of permanent pastures.

The land which is under the plough is very largely devoted to grass or to oats, all other crops being relatively unimportant. As one would expect, cattle farming for beef production rather than for milk is the leading occupation, though sheep are also numerous.

(*b*) *The valleys of North Wales and the Lleyn Peninsula.*—With a heavy rainfall and, in addition, almost constant humidity, permanent grass, as one might expect, is much more important than arable land. Even on the arable land the leading crops are grasses and oats, and as everywhere in the west wheat and barley are unimportant. Several subsidiary crops such as peas and beans common in eastern England are almost unknown; whilst root crops—turnips, swedes and mangolds—are quite unimportant.

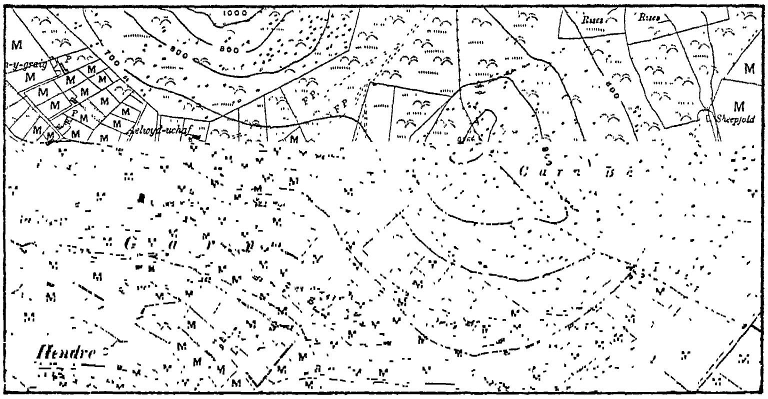

FIG. 115.—A section of country in North Wales.

Typical of farming areas in the highland masses of the western part of Britain—innumerable tiny fields of which about 15 to 20 per cent. are ploughed (shown by dotted areas), the remainder under permanent grass (M), but which may be ploughed at intervals. All have been wrested with difficulty from the main mass [illegible] which will be seen to have re-invaded many of the enclosed areas. Scale, 4 [illegible]. (By permission of the Ordnance Survey and of the Land Utilisation Survey of Britain.)

These lands, of course, are cattle and sheep lands. Again, there is the quite important interchange of sheep between the hill pastures in summer and the lowland pastures in winter.

(*c*) *South-western Wales.*—The western two-thirds of Cardiganshire, the whole of Pembrokeshire, the whole of Carmarthenshire, and the small western portion of Glamorgan lie in general to the west of the great belt of upland pastures. These counties are for the most part under permanent grass. Again there is comparatively little land under the plough. Such as there is is devoted in the main to oats and to sown grasses. When one compares conditions with those in Ireland the small importance of potatoes is remarkable; and indeed so are all root crops. This is pre-eminently a cattle country with a large proportion of dairy cows. Pigs again appear

in numbers, but sheep are now relatively unimportant. It is clear that in this area more attention might be paid to poultry farming.[1]

(*d*) *The Vale of Glamorgan or Plain of Gwent.*—To the south of the moorlands of the South Wales coalfield there is a tract of country which, although it lies within the boundaries of Wales, is really a detached portion of the Midlands and scarplands of England. This Vale of Glamorgan is an area of mixed farming.

(*e*) *The Welsh Borderland.*—To the east of the main central mass of the Welsh mountain moorland or hill pastures there is a belt of country stretching eastwards as far as the limit of the Welsh massif (which may be described as running north and south along the Malvern Hills). It is a varied area with broad valleys penetrating amongst the mountains and including, for example, the Vale of Powis, in which Welshpool and Montgomery are situated, but comprising also rolling uplands such as those which occupy the southern half of the county of Shropshire, Radnor Forest and Clun Forest, as well as the rolling country which occupies the eastern two-thirds of the county of Monmouth. Two areas may be separated from this general mass. One is the Forest of Dean (still largely forested) and the other is the Plain of Hereford. For the remainder it is, for the most part, cattle-rearing country in which permanent pasture is far more important than arable farming, and where the crops grown are limited in extent and character; oats and sown grasses with smaller quantities of turnips and swedes being the chief. On many of the drier pastures sheep are numerous.

(*f*) *The Plain of Hereford.*—This is a remarkable basin-shaped hollow with rich red soil derived from the marls of the Old Red Sandstone. It lies in the lee of the Welsh hills and over the greater part the rainfall is under 30 inches a year. There is little mountain pasture, and although permanent grass is an important feature the distinctive character of this tract, compared with the rest of the Welsh massif, is the considerable acreage under the plough. Oats and appreciable quantities of wheat and barley are grown as well as root crops—including some sugar beet. This is the area which in the eastern part, like the neighbouring parts of Worcestershire, is famous for its hop gardens, the only other centre of importance apart from the Weald. Fruit orchards, particularly of apples, occupy a large area, so that Herefordshire becomes one of the important cider-producing counties. Cattle are, of course, numerous, but sheep not nearly so important as in most parts of the Welsh massif. The Plain of Hereford is a "basin" amongst the hills and may sometimes form in winter a "frost pocket" where cold,

[1] Preliminary results obtained by the Land Utilisation Survey would seem to suggest the great importance of communications. Farms accessible by road or rail are devoted exclusively to grass and dairy farming; farms less accessible are compelled to grow their own requirements of feeding stuff.

heavy and stagnant air tends to remain: in summer fair warm conditions may prevail for longer periods than elsewhere.

4. The South-Western Peninsula

Although this is another area where the old rocks tend to yield an indifferent soil, two features distinguish it agriculturally from other regions in the west of England. One is the plateau character of much of the surface which renders areas easily ploughed, the other is the remarkable mildness of the winter which encourages certain crops to mature early. The higher lands of Exmoor and its outlier, the Quantock Hills of Somerset, in the north, and the granite masses of the south, particularly Dartmoor and Bodmin Moor, as well as Land's End and the Lizard area, are given over to rough-hill pasture supporting but a few sheep. Of the remainder of the area, whilst permanent grass exceeds tilled land in acreage, Cornwall especially is rather remarkable for the large amount of land still under the plough. Certain of the drier tracts with more favourable soil conditions favour limited quantities of both wheat and barley, though of course being in the west of England oats remain the dominant grain crop. But the largest areas of ploughed land are occupied by fodder crops which tend to emphasise the great importance of the cattle-rearing industry, particularly the dairy-farming industry, providing the famous Cornish butter and Devonshire cream. It will be noticed that the emphasis is on butter, cheese, and cream rather than on milk, since the south-western peninsula is too inaccessible from the great centres of milk consumption for fresh milk to be a first consideration. But for direct supply of milk to factories the position is different, and Nestlé's have a collecting station at Lostwithiel. The western half of Cornwall in particular is remarkable for the very high density of the pig and poultry population, whilst the climatic conditions of the sheltered valleys is reflected in the large production and export to other parts of the country of early flowers and vegetables, for example, broccoli.

B. Transitional Regions

5. Northumbria

This region, which may be alternatively described as north-eastern England, occupies the eastern halves of the counties of Northumberland and Durham and a portion of the North Riding of Yorkshire. Broadly, there are two parts: (*a*) the gentle eastern slope of the Pennines and the undulating country between the Pennines and the sea in Northumberland and the northern part of county Durham, and (*b*) the lower Tees basin. The first is a region of indifferent soils, and the proportion of arable land to permanent

grass steadily increases as one gets on to lower ground towards the coast. Durham is world famous for its Shorthorn cattle or "Durhams," but the crops which can be grown are those which are not of exacting requirements. There is very little wheat, for example, and root crops are comparatively unimportant. Near the actual Scottish border, however, the rather richer land there supports a considerable growth of barley and of turnips and swedes. Over the remainder oats and fodder crops are the most important, and reflect the importance of the cattle-rearing and sheep-breeding industries. On the Triassic soils of the lower Tees basin and in the Magnesian Limestone belt of eastern Durham conditions are much more favourable for arable farming. Moderate crops of wheat and barley, and considerable crops of oats, potatoes, turnips, and swedes are grown, and there are large tracts under fodder grasses. Cattle and poultry are important amongst animals; and it is in some respects a function of this region to supply agricultural commodities to the poorer lands further north on the coalfield. The lower Tees basin is linked through the Northallerton gap with the agriculturally comparable Vale of York (see Fig. 113).

6. The Eastern Slopes of the Pennines in Yorkshire and Derbyshire and the Nottinghamshire Border

This region is terminated eastwards by the fertile Vale of York, and in it agricultural conditions resemble in general those of the region further north in Northumbria. Spurs of moorland separate the fertile, attractive and famous Yorkshire dales, and over much of the area agricultural utilisation is overshadowed by industrial.

C. Regions of the Lowland Zone

7. The Plain of Lancastria

Geographically and agriculturally the Plain of Lancastria comprises the western half of the county of Lancashire, that is west of the moorland country, and north of the Mersey valley, practically the whole of the county of Cheshire, the detached portion of Flintshire, and the northern half of the county of Shropshire, including the area round Shrewsbury. The industrial development of South Lancashire has tended to obscure the very great importance of that county from the agricultural standpoint. Practically the whole area is a lowland with a rainfall varying between 25 and 30 inches. Almost the whole is floored by the red rocks of the Triassic period. The soils derived from the Upper Series—the Keuper Marls—are comparatively heavy, and thus differ from those derived from the Lower Series, the Bunter Sands, which are comparatively light. The greater part of the plain has, however, been covered with glacial drift, and it is the character of the glacial drift which really determines local agriculture. In some

areas heavy Boulder Clay is found, unsuitable for cultivation and hence devoted in the main to permanent pasture. Where the soils are lighter and more loamy arable farming becomes important, and there are large stretches to be described as amazingly fertile. Three main areas may be distinguished in the Plain of Lancastria :

(*a*) Lancashire north of the Ribble basin, including the Fylde district, but excluding Bowland Forest, which is an extension of the Pennines. Heavy soils mainly under permanent grass and with comparatively little arable land here prevail. This is an important dairying region with a very large number of dairy cattle, pigs, and a truly remarkable number of poultry. Naturally a large proportion of the products is destined for the industrial towns of the southern half of Lancashire. In addition large numbers of sheep from the neighbouring moorlands are pastured, especially in winter.

(*b*) South-western Lancashire and the Mersey valley. This is a remarkably fertile arable area with an almost complete absence, comparatively speaking, of permanent grassland. It is almost the only area in the west of England where wheat is an important crop, although the conditions are too damp for barley. Oats are also widely grown, but the depth and fertility of the soils available are especially shown in the remarkable concentration here of potato cultivation. Cattle are relatively very few and sheep are practically absent.

(*c*) Cheshire and North Shropshire. The heavy soils of this region are almost entirely under permanent grass, and this is pre-eminently a great dairy-farming region, perhaps the most important in the British Isles. The farms are small, run by the farmer and his family, who in many cases sell milk in the winter when prices are good, and in summer make cheese. Pigs are numerous and so are poultry. The chief cheese makers have formed themselves into a Federation, and cheeses satisfying certain standards are branded "C.C.C." (Choice Cheshire Cheese); the Caerphilly cheese is a special type made for the Welsh mining districts.

8. The Vale of York

This is in the main a tract of glacial drift and alluvium. It was formerly marshy, but is now well drained and extremely fertile. There is much land under pasture, but this may be described as one of the northernmost important arable areas in England. It is certainly the northernmost area where wheat is a crop of first importance and large quantities of barley and oats are also grown. In addition many of the subsidiary crops of eastern England are also to be found here occupying their northernmost position; for example, peas and beans. The deep fertile soils favour root

crops, notably potatoes, turnips, swedes, mangolds and sugar beet. Market gardening is important, but the unique rhubarb-growing area south-west of Leeds is on heavily manured, sour Coal Measure soils. Cattle are numerous but sheep few. The Vale of York extends southwards so as to occupy the extreme north-western corner of the county of Lincoln in the district known as the Isle of Axholme. The region here merges southwards into the Vale of the Trent.

9. The Midlands of England

It is by no means simple to give a general account of the large triangle in the heart of England to which this name of the Midlands of England has been applied. The area under consideration lies east of the Welsh massif, south of the southern end of the Pennines,

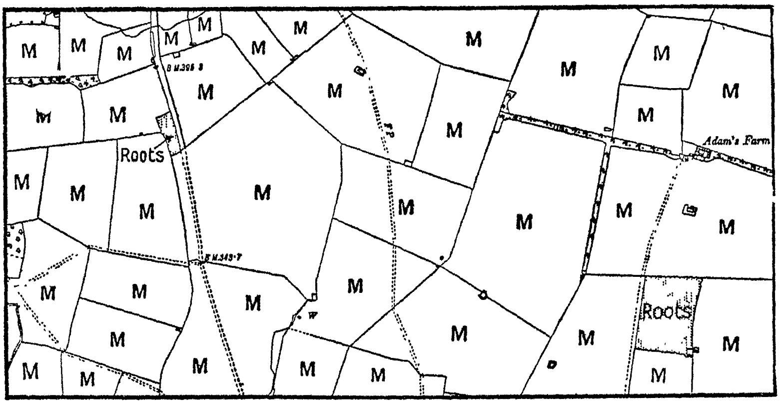

FIG. 116.—A section of country in the Midlands of England.

Typical of farming economy in the damp Midland plains or the clay vales. The land is evenly divided into moderate sized fields, nearly all under permanent grass, [illegible] here and there devoted to root crops for winter feed. Scale, 4 inches [illegible]. (By permission of the Ordnance Survey and of the Land Utilisation Survey of Britain.)

and may be described as bounded on the south-east by the first of the major scarps of the Jurassic rocks which cross England. The south-eastern boundary thus defined does not coincide with any one geological horizon, but with a physical feature which, though discontinuous, can be well seen on the ground. The large triangle so delineated includes the southern two-thirds of Staffordshire, practically the whole of the county of Warwick, the greater part, except the north-western corner, of Worcestershire, and stretches south-westwards to comprise the Vale of Evesham and the Vale of Gloucester which lies between the Welsh hills on the one hand and the remarkable scarp of the Cotswolds on the other. To the north-east it may be described as including the whole of the county of Leicestershire and a portion of western Rutland, as well as just the

borders of Northamptonshire. It extends farther north-eastwards, so as to include the greater part of Nottinghamshire and the western fringe of Lincoln as far east as the scarp of Lincoln Edge, which passes northwards through Lincoln itself. In general terms this is a low-lying area with rather heavy clayey or marly soils derived for the most part from the Keuper Marls and from the clays of the lower part of the Jurassic series (especially the Lias). This is, *par excellence*, grazing country and is almost entirely, over huge tracts, under permanent pasture. In the Middle Ages it is clear that considerable areas were ploughed, and many of the fields of to-day show the well-known ridge and furrow structure indicative of early attempts to drain the heavy soils. In general there is remarkably little arable land in the whole of this Midland triangle, and cattle rearing is pre-eminently the most important industry. But the heavy soils of the Midland plain are interrupted over considerable areas by the occurrence of tracts of different soil. There are in the first place areas where the Bunter Sandstone outcrops and where the soils are light. Much of this ground is rather infertile and is still covered with woodland, as, for example, the Sherwood Forest of Nottinghamshire and the Forest of Arden in Warwickshire. Then there are again hilly or upland areas formed by the outcrop of old rocks, such as Charnwood Forest. Finally, in the east there is a tract of country occupying roughly the eastern half of Leicestershire, somewhat intermediate in character, between the Midland lowlands properly speaking and the hills of the scarplands. In this latter tract there is a little arable farming, but considerable tracts of rather drier pastures suitable for large numbers of sheep—especially the famous Leicestershire breed. Lying just to the south on the borders of Northamptonshire is one of the best known centres for cattle feeding in England. These famous fattening pastures of the Melton Mowbray to Market Harborough area are amazingly good—one bullock and one sheep per acre can be fattened and the great secret is close grazing. The cattle and sheep are purchased from March onwards and sold for killing from July onwards. In the winter this is a great fox-hunting country. Towards the south in the Vale of Evesham and in parts of Worcestershire soil conditions favour the extensive growth of orchards, and there is a closely associated vegetable cultivation.

10. East Yorkshire

East Yorkshire falls clearly into four agricultural divisions:

(*a*) *Cleveland Hills and North York Moors.*—This is a plateau dissected by deep valleys. Rough-hill pastures and moors occupy the higher parts of the hills; in the valleys there are considerable areas of pasture, but despite the position on the drier eastern side

of Britain there is little cultivation owing largely to the prevalence of steep slopes and liability to floods.

(*b*) *The Vale of Pickering.*—This remarkable basin once occupied by a lake now consists of well drained arable land reminiscent of Fenland. The position of the villages on the fringe is worthy of note.

(*c*) *The Yorkshire Wolds.*—Stretching in the form of a broad crescent from the Humber to Flamborough Head are the Yorkshire Wolds. The top of these hills is almost bare chalk, but the dip slope in the East is covered with varying thicknesses of boulder-clay. Thanks to some early and far-seeing enclosure initiated by the Sykes family, the Wolds are cultivated all over, and it says much for the excellent farmers of this district that they can successfully cultivate on such a small thickness of soil. There is little permanent grass in this area, the whole of the farming depending on the Norfolk rotation with the folding of sheep (especially Leicesters) on the clover and the turnips and swedes; without this folding and its consequent manuring, agriculture would be far less efficient. "Downland" is non-existent.

(*d*) *Holderness.*—This lowland, covered with deep boulder-clay and patches of sand and gravel, has been drained with difficulty and is in the main cultivated, the chief products being wheat, roots and cattle.

11. Lincolnshire

The Lindsey District of Lincolnshire repeats the conditions found in the East Riding of Yorkshire. The Trent Vale in the west of the county is part of the Midlands of England and has the damp cattle pastures already described, though there are here considerable areas under cultivation. Then comes the narrow Lincoln Edge, then the Vale of Lincolnshire—partly arable, partly permanent grass—then the Lincolnshire Wolds which repeat the conditions found in the Yorkshire Wolds, and then the Lincolnshire Marshes along the coast which repeat the conditions found in Holderness.

12. The Scarplands and Clay Vales

Stretching right across England from Lincolnshire (East Yorkshire having been separately considered), really from the neighbourhood of Lincoln itself to the Dorset coast, there is a series of discontinuous, west-facing scarps, accompanied by long, gentle easterly dip-slopes (cf. pp. 44–48). The uplands are built of limestones, calcareous grits or sandstones, and the well drained higher levels are given over to arable land or to sheep pastures of short springy turf according to the relative fertility of the soil. This is a land of mellow stone villages, the stone houses often with roofs of thin

stone slabs.[1] As one passes southwards and eastwards so the hills fade gradually into the Great Clay Vale, which may be said to extend as far as the great ridge of the chalk. It runs from the borders of the Fens on the north-east to the Dorset-Devon coast on the south-west; though south of the latitude of Bath the valley itself is ill defined. In places the main vale is interrupted by low ridges where harder rocks crop out at the surface, but on the whole it is a low-lying belt of clay giving rise to heavy soil. Permanent pasture and cattle rearing is the keynote through the greater part of the area. This applies to much of the county of Northampton,[2] the

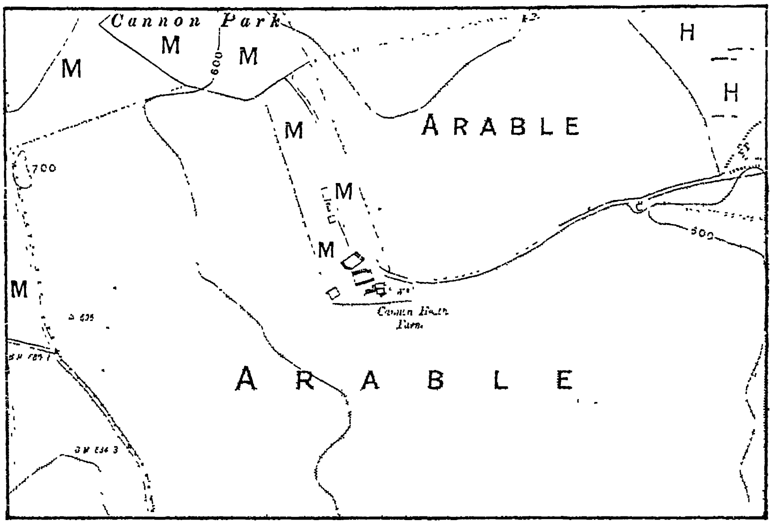

FIG. 117.—A section of country on the "downlands" of south-eastern England with huge open stretches of ploughed land, limited areas under pasture (M), and the poorer land left as rough pasture (H) for sheep. Scale, 4 inches to 1 mile.

(By permission of the Ordnance Survey and of the Land Utilisation Survey of Britain.)

northern half of Buckinghamshire, the great central tract of Oxfordshire, and the north-western part of Wiltshire. The belt extends into the eastern and southern parts of Somerset and the neighbouring parts of Dorset and Devonshire. It is from these regions in the last-mentioned counties of Wiltshire, Somerset, and the borders of Dorset that much of London's milk is obtained, for it is pre-eminently a dairy farming country. The well known Wiltshire bacon indicates an important subsidiary industry. Returning to the north-east where the great clay vale abuts on the Fenland,

[1] Some of the best-known used for this purpose are the "slates" of Collyweston and Stonesfield.

[2] Except the mainly arable Ironstone belt with its rich red soils.

there are large tracts covered with glacial deposits, particularly chalky Boulder Clay, affording excellent mixed soils, with the result that large areas in Huntingdonshire and the southern part of Cambridgeshire and Bedfordshire are arable land, or market gardens producing large and varied crops.

13. The Fenlands

The once practically useless marshland known as the Fens has now been almost completely drained. The great work of reclaim-

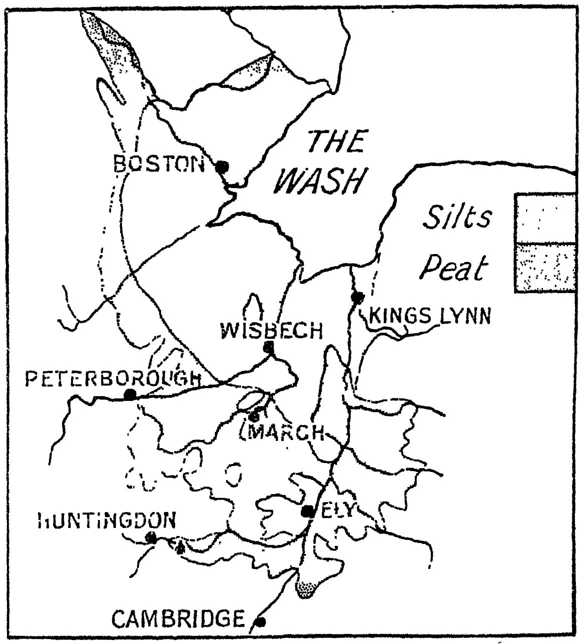

FIG. 118.—The Fenlands.
Uncoloured areas are largely of boulder clay. Notice the boulder clay "islands."

ing the pestilential swamps [1] was begun in the 17th century with the help of Dutch engineers. Both the dark coloured mild peat soils of the drained fens and the silts of land reclaimed from the Wash are amazingly fertile. This is undoubtedly the most intensely cultivated arable area in the British Isles. It comprises the whole of the Holland district of Lincolnshire and the whole of the Isle of Ely, together with the neighbouring parts of the Lindsey and Kesteven divisions of Lincolnshire and the fringe of Norfolk. More than three-quarters of the whole area is under the plough and amongst the great variety of crops grown are large quantities

[1] As on the Essex and other marshes, malaria was formerly rife.

of wheat and sugar beet. Special mention may be made of potatoes (see p. 174), since this is the greatest area of potato cultivation in the British Isles, and of mustard for the factory at Norwich. The limited areas of pasture are found especially on the old "islands" of boulder clay (see Fig. 118).

14. The Plain of Somerset

By way of contrast to the last area may be mentioned the Plain of Somerset, between the Mendips and the Blackdowns. Lying this time on the wetter side of England, it has not been so adequately drained, and is therefore still occupied by wet pastures, and parts

FIG. 119.—Peat-cutting in Somerset.
Deep peat has been formed in many of the low-lying areas of Somerset.

are liable to almost annual floods. The wet pastures afford excellent cattle country, especially along the Parrett. But there is magnificent arable land in the Vale of Taunton and the little Vale of Porlock.

15. The Chalk Lands of the South-east

The chalk lands comprise the well known North and South Downs, the great open chalk downs of Wiltshire and the northern part of Hampshire, and the stretch of chalk country forming the Chilterns and passing away into the East Anglian Heights. Farther to the north-east the chalk occurs over wide areas in East Anglia, but is so masked by glacial deposits that the land is entirely different in character. At least four types of land are found along the great Chalk Belt. First may be mentioned the huge tracts of arable land with a wide variety of crops. In the second place, where the land

is not sufficiently good for ploughing or where the elevation is perhaps too great, the chalk instead is covered by short grass pastures affording that springy turf so characteristic of much of the area. These short pastures are essentially sheep pastures. In the old days the sheep fed by day on the grass, and at night were folded on the fallow arable land which they enriched with their manure. Later root crops were grown on the fallow for the sheep. Each region of the chalk evolved its own type of sheep—the Southdowns and Wiltshires are examples, which when crossed gave the Hampshire Downs. In the third place, especially where there is a gravel coating, the chalk pastures may become rougher in character, gorse and bushes may appear. One gets, therefore, a proportion of rough pasture. It is land of this character which has been utilised for the military training grounds of Salisbury Plain. In the fourth place the surface of the chalk is frequently covered by a residual deposit known as clay with flints. This is a remarkably tenacious brown clay from which the lime has been almost entirely leached away; it frequently gives rise to patches of damp oak woodland, or where this has been cleared, to damp pastures supporting numbers of cattle—a remarkable contrast to the valley slopes on the actual chalk itself near at hand. Sheep kept on the short chalk pastures benefit the ground not only by their manure but by treading down the grass. It is found that the heavier cattle do this even more effectively, hence the evolution of sheep plus cattle farming. As it is no longer economic to grow crops for sheep, the total numbers of animals tend to decrease and they are pastured rather on grass.

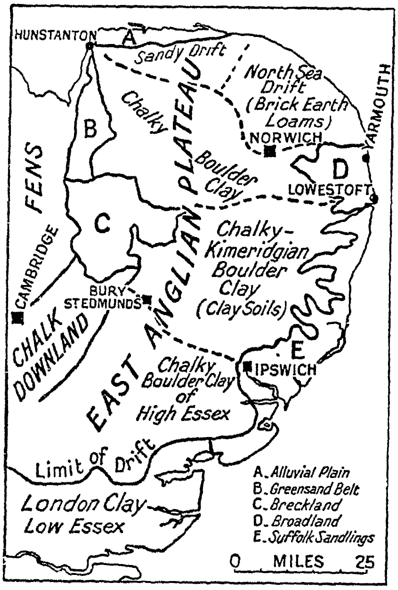

Fig. 120.—East Anglia.

Agricultural regions (based on those suggested by Prof. P. M. Roxby), with the East Anglian Plateau subdivided according to the character of the boulder clay (after maps by the late F. W. Harmer). Limit of Drift in Essex after S. W. Wooldridge and D. J. Smetham.

16. East Anglia

East Anglia, comprising the greater parts of the counties of Norfolk and Suffolk, as well as the northern two-thirds of Essex,

may be described, broadly speaking, as a low plateau. Chalk occurs under a great deal of the area, but its characteristic feature is the wide mantle of glacial deposits. The surface utilisation and the type of farming depend upon the characters of the glacial deposits (see Fig. 120). The central belt is occupied by mixed loamy soils and is excellent arable country. Nearly half the arable land is under cereals: farmers on the lighter soils grow barley, on the heavier wheat. Formerly sheep were fed on swedes, and big Irish shorthorn bullocks fattened for Christmas. Now sugar-beet tops are used, and grass-fed lamb is important, whilst young bullocks are winter fed on roots and fattened on grass in summer. In the west where there are coarse sands occurs that huge infertile tract known as the Breckland, whilst similar sandy and infertile tracts, the Suffolk sandlings, tend to occur near the coast in the east. On low-lying clay country mainly to the east of Norwich are the well known Norfolk Broads. On all heavier soils dairying is spreading, the Dutch Friesian cattle being very popular. The southern limit of this area [1] extends to the limit of the chalky boulder clay; farther south are the heavy lands on the London Clay itself.

17. The London Basin

Although a comparatively small area, the London Basin is agriculturally remarkably complex. At least four major types of land must be distinguished:

(*a*) The London Clay lands which give rise to low-lying belts of heavy soil covered with permanent pasture and utilised as cattle grazing areas. Many areas are still forested, *e.g.* Epping Forest, which was for many centuries a royal hunting ground.

(*b*) The sandy areas, more particularly the great Bagshot Sand plateau towards the west of the basin, giving extremely infertile coarse sandy soils occupied largely by heathland and pine woods.

(*c*) The belts of mixed soils, usually excellent loams, particularly conspicuous along the southern margin of the basin in north Kent. This is the great market gardening and fruit farming belt of Kent, supplying enormous quantities of fruit and vegetables to the metropolis, and important in the eastern part for its crop of hops. Compare also the Lea Valley and Bedfordshire Plain.

(*d*) In the fourth place there are the stretches of terrace gravel which occur in the Thames Valley, for example, over much of Middlesex, and again afford excellent soils famous for market gardening and fruit (see Fig. 43).

[1] As defined by Wooldridge and Smetham.

18. The Hampshire Basin

In many respects the Hampshire Basin repeats the features seen in the London Basin. There are the heavy clay areas largely occupied by permanent pasture, the belt with mixed soil largely cultivated, the huge tracts of barren sandy soil occupied in particular by the New Forest and, less extensive, the belts of gravel or alluvium. It should be noticed that both in the London and Hampshire Basins, as well as of course in the neighbouring parts of the chalk lands and in the Wealden belt, agricultural utilisation depends very largely on economic conditions and the requirements of the great metropolis.

[*Photo : L. D. Stamp.*

FIG. 121.—Timberscombe, near Fernhurst, Sussex.

Typical of Tudor and Stuart domestic architecture in those parts of south-eastern England where timber abounded, but stone was scarce—hence half-timbered brick work This fine old house is now a guest house.

19. The Weald

Inside the area defined by the North and South Downs there is that famous area the Weald. In the heart is a large sandy area occupied largely by Ashdown Forest and tracts of heathland; towards the margins are the sandy ridges of the Greensand of comparable character, including the wide stretches round Hindhead. Most of the rest of the Weald is occupied by the Weald Clay and other clay beds giving rise to a wet country, formerly covered with damp oakwood but now cleared and occupied almost exclusively by pasture land on which cattle are reared in numbers. Round the

fringe of the Weald in what is often called the Vale of Holmesdale there is a belt of mixed soils excellent for cultivation. It is on some of the better soils in Kent that one finds the well known hop gardens and orchards. A small but important region within the Weald is Romney Marsh, now largely drained and used, curiously enough for sheep and not for cattle, being the home of the well known specialised Romney Marsh breed. In summer some tracts of this rich pasture land carry and fatten six or eight sheep and lambs per acre, in winter only the breeding ewes remain.

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CHAPTER XIII

THE REGIONS OF IRELAND WITH SPECIAL REFERENCE TO AGRICULTURE

THE natural vegetation of an area frequently, one might say usually, affords an excellent index of the potential value of the area for economic development. This is because the sum of the influences of the primary physical factors, such as those of physiography (elevation, aspect, slope, etc.), surface geology as reflected in soils, climate, and weather, are all reflected very definitely in the character of the natural vegetation cover. In the case of a country such as the British Isles which has long been settled by the human race the natural vegetation has largely been swept away and its place taken by crops encouraged by man. But the geographical factors are equally potent in determining the type of agriculture which is possible, and just as each type of environment produces its own natural vegetation so each type of environment tends to produce its own characteristic agriculture. As already explained (see Chapter X) economic factors in this modern world may tend to accentuate and increase the importance of individual crops or individual phases of agriculture, but on the other hand they now render impossible the cultivation of a crop or the prosecution of a type of agriculture in a region where geographical conditions are unsuited. Thus agricultural regions in Britain tend to be more clearly differentiated to-day than they were a couple of centuries ago.

In a country, which is still predominantly an agricultural one, such as Ireland, one finds, therefore, that if one attempts a division of the land into agricultural regions these correspond with the regions which would be determined from other standpoints. They are, in fact, the natural regions of the geographer. No excuse therefore is made for dividing Ireland up into natural regions having special reference to the importance in that country of agriculture.

REGIONS OF EIRE (THE IRISH FREE STATE)

The old statement that Ireland is shaped like a saucer with a central plain and a rim of mountains, will be familiar to everyone. It tends rather to blind one to the fact that the rim is of very irregular character and really consists of a number of isolated mountain masses, the Central Plain reaching the coast in more than

one place. Further, the Central Plain itself is interrupted, especially towards the southern and western margins, by numerous ranges or isolated masses of hill country. Primarily one may distinguish the following main physical regions in Eire :

(1) The mountains and uplands of the south-east (Wicklow and Wexford).

(2) The parallel ranges and valleys of the south-west.

(3) The mountain masses of the north-west (Connemara, Mayo, and Donegal).

(4) The uplands of the north-east which are a continuation of the uplands of Northern Ireland.

(5) The Central Plain and its fringing areas.

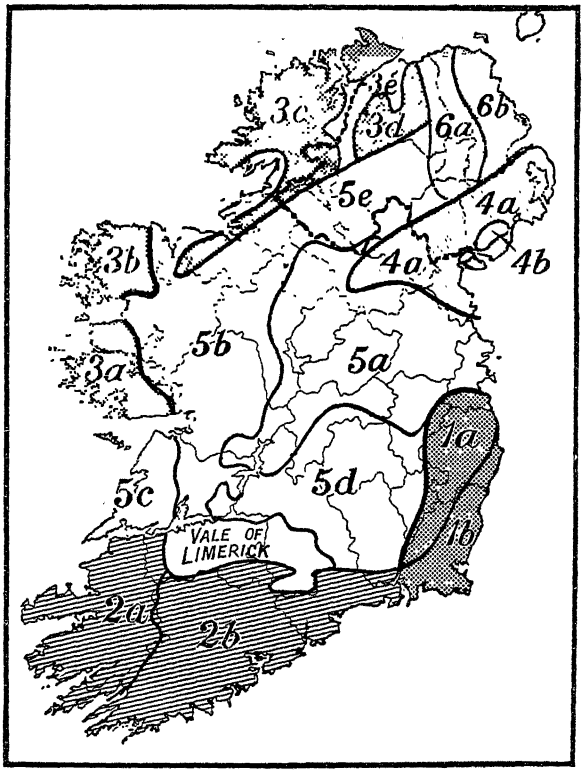

FIG. 122.—The Agricultural Regions of Ireland.
For explanation, see text.

(1) The Mountains and Uplands of the South-East

This well-marked area was doubtless once continuous with North and Central Wales, with which the south-eastern part in particular is structurally similar; the northern part (actually forming the

Wicklow Mountains) consists in the main of the largest granitic intrusion in the British Isles. There is thus geographically a twofold division of the whole area :

(*a*) The *Wicklow Mountains*, which narrow southwards on the other side of the gorge of the river Slaney to Mt. Leinster and the Blackstairs Mountains.

(*b*) The *low plateau* or *uplands of County Wexford* which extend northwards, narrowing to form the coastal belt of the eastern part of Wicklow.

The whole region is remarkable in the first instance because of the completeness of the barrier which it offers between the south-eastern coast of Ireland and the central lowlands. The whole region may, alternately, be called the Leinster Chain, and to this day no railway crosses this barrier. Further, the main mass of the Wicklow Mountains is uncrossed even now by a motor road. The area may now be considered in its two parts.

The *Wicklow Mountains*, reaching northwards almost to the outskirts of Dublin, are remarkable, not only for the barrier which they offer, but also for the contrast between the wide open moorlands of the higher parts, and the deep secluded valleys of the east. The moorlands reach elevations of over 3,030 feet in Lugnaquillia, the highest summit in eastern Ireland, whilst a very large number of the rounded summits of the moorlands reach over 2,000 feet. The breadth of the Wicklow Highlands varies between 10 and 15 miles. The streams which rise in the moors flow in comparatively broad shallow valleys until they reach the areas of slope which flank the chain itself. Here the descent is continued in deep gorge-like valleys which are frequently richly wooded, and these glens have long been famous for their scenic beauties, well-known examples being the Glendalough valley and the Avoca Vale. It is towards the south that the granite ridge is breached by the river Slaney which passes through a deep gorge guarded by the village or small town of Clonegall. To the south-west of the Slaney gorge the Mt. Leinster-Blackstairs range has two nuclei each over 2,400 feet in height separated by the Scullogue Gap, a defile which has been used in the past by bold chieftains desiring to travel from Enniscorthy, the tidal head of navigation on the river Slaney, to Kilkenny, the next important centre towards the heart of the country. Because of their elevation the Wicklow Mountains experience a heavy annual rainfall, in spite of their situation on the eastern or drier side of Ireland. But in the secluded glens of the east the rainfall is less, and these glens benefit from the high summer temperatures, the July mean being over 60° F., although it is of course lower than in the corresponding regions in eastern England. These eastern glens, being sheltered from the rainy westerly or south-westerly winds,

form one of the few areas in Ireland where considerable extents of woodland have been preserved. Wicklow timber was valued in very early times and a process of systematic deforestation began when the Anglo-Normans of the Pale exported the oak and other woods in large quantities. The suitability of the area for afforestation has been recognised in recent years, and considerable areas have been planted. Agriculturally, the main importance of the area is for the sheep pastures which are afforded by the open moorland, but there are restricted though good areas of cultivation in the secluded vales. For long the tribes of the Leinster Chain maintained a sturdy independence. They had their strongholds at the entrances to the narrow valleys which led to the high moorlands, and to which they could retreat if need should arise. Yet from the Bronze Age onwards the mineral wealth of Wicklow caused traders to be attracted to the district, particularly for gold and copper, ores of which occurred on the eastern side of the Highlands, and which became known to the people of all Ireland.

The *Wexford Uplands and Plains.*—To the south and east of the Wicklow Mountains there lies an area almost completely cut off from the remainder of Ireland. It occupies the greater part of Wexford and narrows northwards to form a small plain between the Wicklow Mountains and the sea. It is an area of old rocks which weather to form a moderately good soil. Over large areas glacial deposits are absent. Where they occur they consist mainly of shallow sands, marls, and clays which help to produce soil of excellent quality. This corner of Ireland has relatively dry warm summers, and the climatic conditions combined with the soil have produced here what is *par excellence* the barley-wheat region of the country, in which potatoes and pigs are also important. The country is undulating, and generally well drained so that bogs are almost non-existent. Although naturally not nearly so predominantly arable as the eastern parts of England, nearly a third of Wexford is recorded in the returns as arable. Despite this agriculturally favourable aspect of the country its isolation by nature is apparent from the numerous primitive little whitewashed cabins which are so reminiscent of the remote west. Northwards, where the plain narrows to the strip between the Wicklow Mountains and the Wicklow coast, is an interesting area sometimes referred to as the "Garden of Ireland." It is pleasant, comparatively well wooded "close" country of very English aspect, free from bogs, and supporting numbers of dairy cattle as well as sheep. It is from this area that the valleys penetrate into the mountains. It might be thought that this pleasant coastland would have been subject to invasions from the east, that is from the other side of the Irish Sea, but actually throughout historic time it was dominated by the tribesmen of the Wicklow Hills. The presence of such a stronghold of hill people near Dublin

was for very long a source of danger and difficulty to those who sought to establish authority over the whole of Ireland from its natural centre at Dublin. Thus as late as 1800 it was necessary to construct a military road to traverse the high moorlands from Dublin to the Aughrim Valley. Even to-day the one main road and railway which connects Dublin with the south-east of Ireland runs along the narrow coastland through the picturesque watering place of Bray; whilst the famous Round Tower of Glendalough remains there as a permanent reminder of the long held strongholds of early Christianity in the secluded valleys of the mountains.

(2) The Parallel Ranges and Valleys of the South-West

South-western Ireland is built up of a series of long, comparatively barren ridges of Old Red Sandstone trending roughly from east-north-east to west-south-west, separated by damp, fairly fertile valleys of Carboniferous Limestone covered by superficial deposits. The country thus owes its structure and topography to the Armorican series of earth movements. Whilst the hill ridges with their rough sheep pastures and the valleys with their damp cattle pastures and famous dairy herds form one natural twofold division of this part of Ireland, there is another which should be considered. There is the west, corresponding roughly with County Kerry, so cut off from the remainder of Ireland by ridges of mountains that it has been described, not inaptly, as a region under the title of the Munster Barrier. It is here that the wild mountains of Old Red Sandstone reach their greatest elevation, and where the intervening valleys pass seawards into long narrow arms of the sea known as rias,[1] in contradistinction to fiords of different character and origin. To the east the mountains are less rugged and less wild, the valleys broader and of greater importance to the country as a whole; and here is the greatest dairying region in Ireland, with such important centres as Cork and Waterford.

(a) The *Munster Barrier* or *Mountains of County Kerry*.—This region really stretches from the wide estuary of the Shannon on the north to Bantry Bay on the south. The high mountain rampart which separates it from the remainder of southern Ireland on the east and south-east is lofty, bare or bog-encumbered country, intervening between the long valleys opening westwards to the Atlantic and the wide basins of the Lee and Blackwater, rivers draining eastwards and then south to the sea. Amongst the mountains of Kerry are the famous Macgillycuddy's Reeks, with the highest mountain in Ireland. In these peninsulas of the west the mountains occupy most of the country and support on their rough pastures numerous sheep, whilst the farms are smallholdings

[1] A ria becomes progressively deeper seawards; there is not the submerged lip so commonly found in the case of fiords and due to a morainic ridge.

nestling in the hollows. The whole region is essentially a pastoral one, for cultivation is rare in Kerry, and even the fertile tracts are generally used for cattle rearing owing mainly to conditions of climate. Western Kerry has the heaviest annual rainfall for the whole of Ireland, the total in places actually exceeding 100 inches per annum. At the same time the climate is remarkably mild, especially in the winter months, when an average of over 44° is maintained, and a mean January temperature of 46° is recorded in parts of western Kerry, being the highest figure for any area in the British Isles. The heavy moisture and excessive mildness of the climate is reflected in certain local features of the vegetation, rich in ferns and mosses, and even including plants proper to the western Mediterranean. Although to the west the force of winds from the Atlantic may prohibit tree growth, over restricted areas in the more sheltered valleys are the famous woods of Kerry, including in particular the strawberry tree (*Arbutus unedo*). Modern roads no longer leave this an isolated tract, and the wild country is much loved of visitors to Killarney. Previously the district was one of great isolation; the peasant communities of Kerry have remained detached from the main stream of economic, political and social affairs of Ireland. But much of the area is inhospitable and unsuitable to settlement, and the traditional capital of Munster, as well as its important towns, are situated to the east of the barrier. It was only in times of stress that the people naturally withdrew to their mountain fastnesses in the extreme south-west. Even the Viking invaders, used as they were to the mountainous conditions of Norway, preferred to leave this western side of Kerry; though they established settlements at Limerick and at Cork there does not seem to be evidence that they attempted a settlement here.

(*b*) The *parallel valleys of Cork and Waterford*.—This, the eastern half of the south-western region, has many of the advantages (such as mildness of climate and moisture to produce fine pastures) of the mountainous regions of Kerry, but is without its disadvantages. The drift-covered limestone lowlands afford some of the finest pasture in Ireland. The country to the south may be matched by that to the north in the famous Golden Vale of Limerick and Tipperary. This has thus become the greatest dairy-farming region of all Ireland. Turnips and potatoes are grown in the lowlands, oats are mainly restricted to the southern part in County Cork, whilst pigs of course are an important by-product of the dairying industry. It will be seen that in general the rivers and the river valleys have a trend eastwards parallel to that of the mountain ridges. In succession from south to north one may notice the course of the Bandon River, the Lee, and the Blackwater, but the region is not as isolated from the Central Plain of Ireland as might be expected, because of the transverse valleys which interrupt the east-west mountains. An

excellent example is that followed by the railway from Mallow to Cork, affording an easy line of movement between Cork and Limerick. In earlier days these routes were not as easy nor as practical as they are to-day; thus, although Limerick and Cork were settled by allied bands of Northmen, contact was closer between Cork and Waterford than between Cork and Limerick although the settlers in the two latter areas were originally more closely allied. Inter-communication between the farms in the valleys and the main centres has been an essential factor in the development of the co-operative dairy farming. The map here given (Fig. 123) shows that no less than 88 per cent. of the milk produced on the farms in the county of Limerick is dealt with in the co-operative dairies, an indication of the high pitch of efficiency to which the industry has there been taken. Similarly, the establishment of bacon centres at Limerick, Cork and Waterford depends upon the possibilities of developing communications.

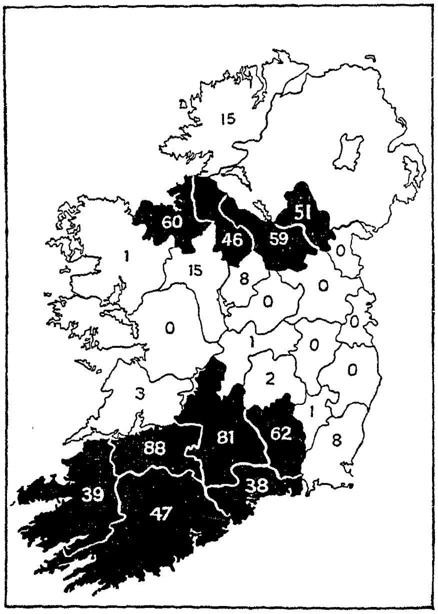

FIG. 123.—Map showing the percentage of the total milk production in each county of Eire which is handled by Co-operative dairies.

(3) The Mountains of the North-West

These mountains are built up of the same ancient metamorphic rocks as those which make up the Highlands of Scotland. The mountain rampart is exposed to the full force of the relentless waves of the Atlantic Ocean. There are innumerable rocky headlands and deep inlets overshadowed by barren rocky heights. In two places the waves of the ocean have penetrated the mountain rampart as far as the fringes of the central lowlands. These two inlets are Clew Bay and the wider Donegal-Sligo Bay, and they have the effect of separating the mountain rampart into three parts: the mountains of Connemara in the south, the mountains of Mayo in the centre, and the mountains of Donegal or Tirconnail in the north. The first two are often linked together as the Connacht

Highlands, whilst the latter is the north-western Highland properly speaking. The whole of this part of Ireland is exposed to the full force of the rain-bearing winds from the Atlantic Ocean. Large areas are so bleak as to be uninhabitable and tree growth is impossible. Extensive areas of the higher land were swept bare of soil during the great Ice Age, whilst between the barren mountains there are huge glaciated surfaces, waterlogged and occupied by vast boggy moorlands which are again practically uninhabited. The small population exists in the valleys and especially along the coast, and like the crofters of Scotland, the people live by carrying on subsistence farming. Sheep live on the better drained slopes and furnish the wool for the famous Irish and Donegal tweeds. Potatoes are often almost the only crop possible, and there is frequently clear

[*Photo : L. D. Stamp.*

FIG. 124.—A typical "cabin" or peasant-proprietor's farm-house in the far west of Ireland.

evidence of conscious and unconscious attempt of man and animal alike to seek shelter on the lee side of hills away from the full force of the Atlantic winds. In such situations are the little homesteads; here alone will trees grow.

(*a*) The *mountains of Connemara*.—This region corresponds with the western third of Galway and the south-western corner of County Mayo. Running northwards from the town of Galway is the Limestone belt which is described below as part of the fringe of the Central Lowlands. Westwards the junction between the often bare limestone surfaces and the ancient rocks of the highlands is usually quite sharp—so sharp that the line can often easily be drawn on a map. Actually along the junction there are frequently prosperous farms in wooded sheltered hollows; but away from this margin stretch mile after mile of almost uninhabited moorland. Shallow

treacherous lakes occupy every hollow, and are in turn fringed by bogs; whilst between the lakes are extensive stretches of bare glaciated rock surface. Rounded mountain masses often practically bare of soil rise in lonely grandeur from the lake-studded lowlands. Their more fertile lower slopes may be covered by a moorland in which bracken and heather are important. Some of the scenic effects, such as the view of the Twelve Pins of Connemara seen from the south, are both majestic and awe-inspiring. Where the glaciated mountains reach the coast, the scenery again is often very fine, as in the fiord known as Killary Harbour. "Much of the sparse settlement in this region is along the coast, where fishing may be combined with subsistence farming, and where seaward drainage helps to improve the natural conditions. Little whitewashed single-

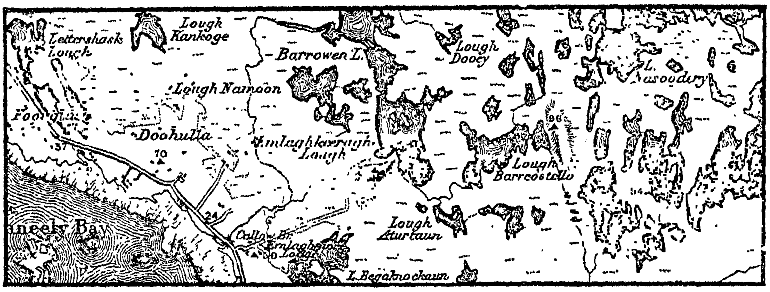

FIG. 125.—Part of the lake-studded lowland of Connemara.
Notice the restriction of settlements to the coast. Scale, 1 inch to 1 mile. Reproduced from the Ordnance Survey map by permission.

storied thatched cabins lie scattered along the coast wherever a few fields sufficiently free from boulders may be secured. Frequently the little farm is situated on a slope with rough sheep pastures above and where hay, oats and potatoes may be grown on a narrow strip of land between the farm and the sea. A few small black cattle, an occasional pig and a few poultry form the rest of the live stock. Such is the character of the country around Clifden."[1] It should be noticed that in this far west even good pasture is scarce.

(*b*) The *mountains of Mayo*.—These are broadly similar to the mountains of Connemara and Joyce's Country to the south of Clew Bay. The width of the mountains of Mayo from north to south—that is from Clew Bay to the north—is roughly 30 miles, but only one road forces its way across them in this distance. The 57 square miles which make up Achill Island, the largest island off the Irish coast, consist almost entirely of wild moorland with only very occasional patches of cultivation. No districts in Ireland are more isolated from the main currents of national life than are these

[1] L. D. Stamp: *An Agricultural Atlas of Ireland*, p. 60.

desolate tracts of western Galway and western Mayo. It is there, not unnaturally, that we find to-day the descendants of the earliest inhabitants of the island. Through the ages the sturdy hillsmen remained in defiance of foreign overlords coming there from across the plains to the east. To this day dark-skinned descendants of Neolithic man are to be found in the hill country of Galway and Mayo. This is, indeed, one of the remotest fringes of Europe. The railway has penetrated to the west coast at Clifden in Galway, but in Mayo has only succeeded in running along the northern shore of Clew Bay, and to obtain public conveyances northwards into the Mayo area is still difficult.

(c) *Donegal* or *Tirconnail.*[1]—In the wind-swept land of Conall the barrenness and rugged character of the Irish highlands reach their maximum, but though the coast is usually very broken and rock-bound the main mountain masses terminate abruptly before reaching the sea, there being usually a low, though narrow, coastal plain which makes possible the existence of a larger population in Donegal than in the bleaker, but less majestic, mountain country of Mayo and Galway. This is readily apparent in the maps showing the distribution of potatoes in the Irish Free State given in Chapter X (see Fig. 94), there being obviously more land under cultivation on the fringe of the Donegal mountains than in either of the preceding areas. This is true, for example, of the coastal fringe of the peninsula of Inishowen.[2] The climate is, of course, characterised by the prevalence of strong westerly and south-westerly winds, bringing a heavy annual rainfall, and by a mildness of temperature at all seasons. This is important. The absence of frost is marked particularly, and it is thus possible for the small cattle breeder of Donegal to allow his animals to remain in the fields even during the winter, at least in most years. The cattle thrive on the verdant pastures which are possible in many of the valleys, whilst on the hillsides are numerous sheep. Woodland is naturally absent in Donegal except on the sheltered, usually the eastern, sides of the hill slopes. On the east the mountainous massif of Donegal abuts against the broad, comparatively fertile, corridor which is formed in the main by the valley of the Foyle River and, by analogy with Scotland, may be called the Foyle Strath. Along it there now runs the boundary between the Irish Free State and Northern Ireland. The rugged mountain scenery of the north-western massif appears again to the east of the Foyle Strath in the Sperrin Mountains of Northern Ireland. The lowland basin of the Foyle has long been the focus of human activities. Strabane is one of the most important road centres of the country, and here the chief tributary of the river Foyle, the river Finn, joins the main stream.

[1] Tir Chonaill=the Land of Conall.
[2] Inishowen=island of Owen.

The valley of the Foyle affords an approach to the heart of the Donegal Mountains where the little town of Glenties is a favourite centre for sportsmen. At the outlet of the Foyle is the important town of Londonderry.

(4) The Uplands of the North-East

Lying in the counties of Cavan, Monaghan, and Louth is the continuation of the rolling country more fully described under Northern Ireland. Though the old rocks are largely masked by glacial deposits, the drainage here is much better than in the plains of central Ireland to the south; bogs become infrequent, but as in the neighbouring parts of Northern Ireland, there are rich pastures, more accessible than those amongst the bogs and so giving rise to a country where dairy cattle are important, and where there is an extensive cultivation of potatoes, as well as of oats, and in the drier east some barley and wheat. Pigs are numerous as a by-product of the dairy-farming industry; sheep are numerous on the drier pastures.

(5) The Central Lowlands

Now that the fringing highland masses of the Irish Free State have been described, there remains a great central region which is on the whole a lowland. It seems best to consider it as made up of four parts:

(*a*) The Central Plain properly speaking which is, in the true sense of the word, a plain.

(*b*) The Western Fringe, where well-drained areas of glacial deposits and bare limestone tracts are commonly found.

(*c*) The Limestone Highlands of County Clare.

(*d*) The Southern Area, where great tongues of lowland are separated by hill masses, and where the fertile river valleys merge insensibly into the similar valleys of south-western Ireland.

These four divisions may now be considered in order.

The Central Plain.—On the ordinary solid geological map this tract appears as a broad sweep of Carboniferous Limestone, which extends also to the western fringe and far to the south. In the Central Plain, properly speaking, the limestone is, however, rarely seen. It is masked by a spread of glacial and later deposits. There are wide areas of waterlogged boulder clay interrupted by infertile glacial sands and occasionally by loam. On a low-lying area of such a character, drainage is naturally bad. It is rendered worse by the presence of the limestone below, for water tends to pass through fissures in the limestone rather than across the surface by regular watercourses. The curse of the Central Plain is thus bad drainage

and consequent formation of huge bogs. The Central Plain is thus the country of the great bogs for which Ireland is far famed. Away from the bogs it is a land of wet pastures where little cultivation is possible. The whole may indeed well be described as the Beef- and Bog-land of Ireland. Some of the larger bogs may be five, or even ten, miles across; and it is not infrequently a journey of several miles from a main road to an isolated farm. With such

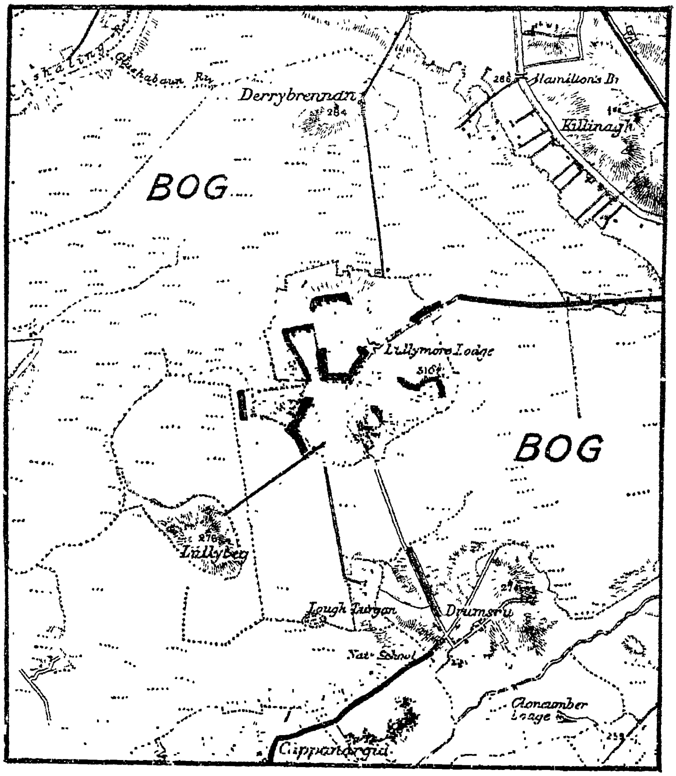

FIG. 126.—Part of the Central Plain of Ireland, in the region of the great bogs, showing "islands" of well-drained sands, very difficult of access, in water-logged bogland.

Scale, 1 inch to 1 mile. Reproduced from the Ordnance Survey map by permission.

difficulties of communication it is obvious that dairy farming is practically impossible. The regular collection of the milk for a central creamery would be out of the question. If dairy cattle are kept, as they are in small numbers, butter is made at the individual farms. On the other hand the damp pastures are, of course, excellent for cattle. Hence, as the map showing the distribution of beef cattle indicates, there is an immense concentration of the stock-

rearing industry on the Central Plain. Especially in the immediate hinterland of Dublin are there immense numbers ready in normal times for export to Britain. There is little cultivation of land, but the importance of potatoes relative to oats indicates the greater adaptability of potatoes as a food crop. In the south turnips become important—obviously grown as a cattle food. The Central Plain reaches the Irish Sea in the lowland stretch between the Wicklow Mountains on the south and the low hills of County Louth on the north. Here is the obvious gateway to the heart of Ireland, and the natural position for the capital. Notwithstanding the fact that Dublin is thus the natural port of entry, and the gateway into Ireland, communication across the Central Plain is not easy. It has been definitely facilitated, however, by the presence of ridges of glacial origin which pass more or less in an east-west direction across

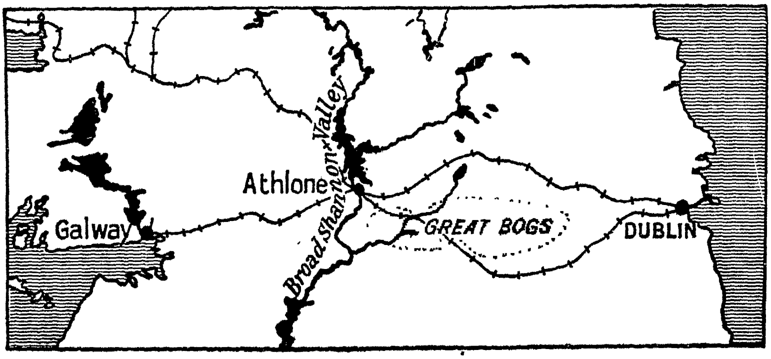

Fig. 127.—The position of Athlone.
A crossing place of the broad Shannon Valley.

the Plain, and the old roadways followed these lines of sandy eskers. There is one running almost directly westwards from Dublin as far as the west coast in Galway Bay (see Fig. 77). Even when the land of the great bogs has been traversed, there is the difficulty of crossing the wide marshy valley of the Shannon or the considerable bog-fringed lakes through which the river passes. Thus, naturally, the Shannon formed the boundary between the ancient kingdoms of Connacht on the west and Leinster on the east; whilst the position of the town of Athlone, where a crossing of the Shannon is rendered possible, is doubly emphasised by its present-day importance as a railway junction and as a road centre. The esker ridges consist of roughly stratified sands and gravels, and are normally grass-covered. They are believed by some geologists to mark the courses of sub-glacial streams which were developed towards the close of the Ice Age, by others to mark periods of halt in the retreat of the glaciers. On some of the eskers and comparable

mounds of glacial origin in the north and south of the main part of the Central Plain sheep are numerous. The importance of these glacial ridges is heightened during the heavy rains of autumn and winter when the subterranean waters, such a common feature of limestone country, rise in the neighbouring hollows, locally known as "turloughs," and convert them into shallow lakes. To the south-west of Dublin is the Kildare country—especially famous for its breeding of race-horses and Irish hunters. Even the wettest parts of the Central Plain—for example, the Shannon Basin—are actually at a considerable height above sea-level, and it is, of course, this fact which has made possible the development of the Shannon hydro-electric power scheme. Consequently, towards the eastern section of the Central Plain, where drainage to the sea is better, there are tracts much more favourable for the development of agriculture. Here the seasonal temperatures are the most extreme for Ireland, though even so the variation between average January and July mean temperatures is only about 20° F. The effect of prevailing westerly or south-westerly winds on vegetation is much less marked, and tree growth tends to be more abundant. On the other hand cold easterly and north-easterly winds in winter are able to penetrate a considerable distance into the central lowlands. Along the coastal fringe, the cultivation of barley, wheat, and potatoes is seen to assume a greater importance. It is a matter of the greatest significance that this better drained land should be on the eastern side. The Central Plain has been in each epoch of invasion the home of the foreigner who has entered from the Irish Sea. The Vikings established their settlement in Dublin, and the port became the stronghold of the stranger just as it has been at many succeeding dates. The Anglo-Normans established in Dublin their outpost from England and their headquarters for the conquest of the wide Central Plain. Not unreasonably the holder of the port of Dublin would feel confident ultimately of establishing authority throughout the island, and at the same time ensuring protection to commerce in the Irish Sea by preventing raiders leaving *from* the natural gateway of the country. Although clansmen might remain virtually independent in the distant hills, the lord of the Central Plain was virtually the King of Ireland. This is, when one considers it, obvious, although at first sight remarkable in view of the by no means favourable conditions of the whole of the Central Plain.

The Western Fringe.—This seems a convenient designation for a belt of country lying between the Central Plain properly speaking and the old mountains of the north-west. Actually it consists of two contrasted types of country. There are areas where the Carboniferous Limestone reaches the surface and gives rise to dry Limestone country covered with sparse sheep pastures, and other areas where the surface soils are of glacial origin but comprise

stretches, the gentle slopes of the mounds being either occupied by cropped land or hay; whilst the driest slopes are given over to sheep. This type of country is well seen in the plains of Mayo or in the country round Clew Bay, or from Westport to Castlebar and Swineford. It stands out on the agricultural maps as the belt where the cultivation of oats and potatoes is important, and which has large numbers of cattle, sheep, and pigs. Where masses of the older rocks appear through the limestone or the cover of glacial deposits they give rise to mountains (of which the Ox Mountains may be quoted as an excellent example) forming a sort of outer rampart or bulwark of the Connaught (Connacht) Highlands against the Central Lowlands.

The Limestone Uplands of County Clare.—Here in the west is a typical limestone area, but one which has few glacial deposits. There are wide stretches of open grassy moorland comparatively free from peat, whilst flat-topped hills with abrupt edges, built up of almost horizontal limestone beds, break the monotony of the scenery. These limestone tracts are sparsely inhabited, and support mainly a limited number of sheep. Isolated tracts of a similar character occur fringing Sligo Bay near Sligo itself. In the southern part of County Clare are drift deposits which support pastures and share in the dairy-farming industry of County Limerick.

The Southern Area of the Central Plain.—This, perhaps, is the most difficult part of Ireland for which one may attempt to give a general description. The Central Plain with its great bogs passes southwards into an area where the plains are interrupted by numerous hills. Some of these are anticlinal masses where the older rocks—the Old Red Sandstone—are found outcropping from beneath the Carboniferous Limestone. Others, on the other hand, are synclinal areas where patches of Millstone Grit have been preserved in basins in the Carboniferous Limestone, but owing to their greater resistance to subaerial denudation stand up as hill masses. In the heart of the anticlinal hills of Old Red Sandstone still older rocks appear, and thus one gets barren rocky mountains with poor pasture, such as are found in Slieve Aughty, Slieve Bernagh, the Arra Mountains, Slievefelim, and Slieve Bloom. It will be noticed that in the neighbourhood of Killaloe on the Shannon, just to the north-east of Limerick, two of these masses of ancient rock approach close to the Shannon itself. It is here that the Shannon passes over the rapids from Lough Derg (116 feet above sea-level) before reaching the town of Limerick, and it is the succession of rapids which have made possible the construction of the hydro-electric power works (see p. 93). Between the various hill masses there are broad tongues of lowland or corridors, which can be regarded as offshoots from the Central Plain. These fade southwards into important river valleys. Speaking generally, the valleys afford

much cultivated land, especially on the slopes. Oats, potatoes, and turnips are grown. In the drier and more sheltered valleys further to the south-east, barley becomes important. There are also very extensive cattle pastures, and the drier hill slopes above support numbers of sheep, whilst in the centre of the valleys themselves there are often extensive bogs. The easternmost of the larger valleys is that of the Barrow in which sugar-beet and mangolds are cultivated. The western part of the whole tract comes within the main dairying belt of south-western Ireland, and it is here that the most famous, and perhaps the most fertile, part of Ireland—the Golden Vale of Limerick—lies between the region now under consideration and that which has been described under south-western Ireland. On the other hand the north-eastern portion of this varied tract is more closely allied with the Central Plain and, like the Central Plain, is famous for its beef cattle.

Regions of Northern Ireland

Since in Northern Ireland are to be found continuations of the great masses of Scotland from which the country is separated only by the North Channel with an average width of a little over 20 miles, it might be expected that Northern Ireland would fall into three primary divisions:

(*a*) The northern mountains akin to the Highlands of Scotland lying north of the great boundary faults.

(*b*) The continuation of the Midland Valley of Scotland occupied by the Carboniferous Limestone and other Carboniferous rocks.

(*c*) The continuation of the Southern Uplands of Scotland comprising the country to the south of the boundary fault.

Actually, however, the structure is complicated by the fact that the Chalk Sea spread over the greater part of Northern Ireland and wore down the ancient rocks and deposited over them, as well as over the rocks of the Midland Valley, considerable layers of chalk. At a later date, that is in the Tertiary Period, these beds of chalk were covered by enormous stretches of basaltic lavas poured out from great fissures. Hence there is a huge lava plateau over a large part of the country. But this lava plateau has subsided towards the centre where it is occupied by the shallow waters of the largest lake in the British Isles, Lough Neagh. There is thus at the present day a rather remarkable contrast between the higher parts of the lava plateau around its rim and the subsided central portion. The regions which result, which are both natural regions and agricultural regions, are shown in the accompanying diagram (Fig. 122). It must also be remembered that Northern Ireland was severely glaciated during the great

Ice Age, so that soil and loose rocks were removed from the higher levels of the old rock masses whilst the lower levels were covered with a thick though irregular mantle of glacial deposits.

The Uplands of County Down and County Armagh.—This unit is convenient because the region is a natural continuation of the uplands of Southern Scotland. There are to be found the same Ordovician and Silurian sediments, but they are in Ireland masked to a greater extent by glacial deposits. There is a further contrast with Scotland in that the whole tract is of lower elevation. Only limited areas rise to over 500 feet, and so instead of wide tracts of moorland are miles of pleasant farming country. To the east, indeed, the uplands pass quite definitely into fertile lowlands which are in turn covered by the shallow waters of the sea in Strangford Lough. Broadly speaking, in the higher parts the soils are stony and poor, the farms small, the farmhouses unpretentious, and sheep pastures an important feature of the surrounding land. The lower undulating country, on the other hand, is a land of relatively prosperous farms, and over all this lower ground cattle, especially beef cattle, are widely distributed, whilst oats and potatoes are leading crops. Taking the region as a whole, sheep are very numerous; their concentration in the higher areas is very marked. The region is generally well populated; market towns are numerous. To the north lie the industrial towns of the Lagan Valley; the port of Newry lies in an important fertile valley to the south-west, while the prosperous seaside resorts of Bangor and Newcastle are both within this area. The proximity of these considerable areas of settlement, but more especially the proximity of Belfast with its population approaching half a million, has a marked influence on the agricultural occupations of the population. The rearing of poultry for the Belfast market and for export is particularly noteworthy, whilst the production of eggs is very large indeed, especially in the Ballynahinch area. In the south of the upland belt is a distinct region, small but remarkably well defined—the Mourne Mountains, formed by a great intrusive mass of granite of comparatively recent age, probably Tertiary. The mountains are rounded in outline, but they rise in Slieve Donard to 2,796 feet above sea-level. Cultivation is absent from the central mass, but very large numbers of sheep are reared on the rough pastures of the slopes. The mountains themselves reach the coast in Carlingford Lough, which may be described as a fiord, and also to the south of Newcastle; but between these two points there is an interesting tract of lowland centring on Kilkeel, which is a tract of small farms and sheep pastures, but where oats and potatoes can be grown in quantity, and where many cattle are kept.

The Plateau and Glens of Eastern Antrim.—This region comprises the higher eastern portions (the land over 500 feet) and the edge of

the basalt plateau, together with the coastal strips which sometimes lie between the edge of the plateau and the sea, and also the deep glens which gash the edge of the plateau itself. Agriculturally, these three parts are to a considerable extent distinct·

(a) The surface of the plateau is wide open moorland, useful only as pasturage for a limited number of sheep.

(b) The coastal strips vary greatly. Sometimes there is a low plateau with a rolling surface formed by the basalt itself, as in Island Magee south-east of Larne. Such country is fertile, and if sufficiently accessible from Belfast, dairy-farming may be important, and potatoes are widely grown. In the north-

[Photo: L. D. Stamp.

FIG. 129.—A chalky lane across one of the small patches of chalk in Northern Ireland.

The suggestion of similarity with the chalk downs of southern England is unmistakable, but the sheep are obviously different.

east of Antrim there is a considerable tract of ancient rock—a continuation of the Highlands of Scotland—cropping out from beneath the chalk and the basalt. These rocks give rise to boulder-strewn moorland sheep pastures, whilst on sheltered valley slopes subsistence farming still remains important. In a few places tracts of chalk are exposed, and there is a sudden change to short springy grass which is indistinguishable, except to the botanist, from that to be found on the chalk downs of southern England; and the white chalky farm lanes and the numerous sheep make the comparison complete (see Fig. 129).

(c) The deep glens are particularly interesting. They are, of course, famous for their scenery. The summer visitor might be surprised if he observed the conditions of these glens in the

winter. They are narrow and bordered by high, often vertical, basalt cliffs, so that the southern side of the valley may not be in sunlight in the winter until as late as 2 p.m. and suffers accordingly. Agricultural conditions and the health of the people improve as one goes to the other side of the valley. In general, the centre of the valley is occupied by ill-drained cattle pastures, and on either side of the road or lane, along the valley side, is a succession of small farms where the farmer grows potatoes and other root crops and keeps a few pigs. In the broader glens and on part of the coastal strip, particularly on the northern shores of Belfast Lough—Belfast to White Head—

[*Photo : L. D. Stamp.*

FIG. 130.—One of the glens of Antrim.

A view taken from the south side at midday in January. The northern slopes are bathed in brilliant sunshine, the foreground remains in shadow, and where the photograph was taken the ground was still frozen hard.

Keuper Marls appear and afford excellent soil capable of intensive cultivation. No one needs to be reminded that where the basalt reaches the northern coast is to be found the most famous of all localities in the whole of Ireland—the Giant's Causeway—the stones of the causeway being naturally formed hexagonal columns of basalt.

The Lough Neagh Basin and the Lower Bann Valley.—Except for the west, the greater part of Northern Ireland may be described as the Ulster Basin, in that a great tract of it drains towards Lough Neagh; agriculturally and otherwise, however, it seems better to separate the lower central part of the great basalt region which lies almost entirely below 500 feet. The underlying basalt is often

hidden by the glacial deposits, and there is a gently rolling surface rather than a level plain. If the basalt itself is exposed, there is often a rich, red-brown, fertile soil, but in many places the gentle slope towards the central lake has waterlogged glacial soils, though the lighter glacial deposits may be well drained. Thus there are large areas of damp pastures characterised by clumps of rushes, and supporting both dairy cattle and beef cattle. Where drainage and soil conditions are better, arable land is found. This is particularly the case on the superficial clays and alluvium lying to the south-west and west of the lake. Here oats are grown in quantity,

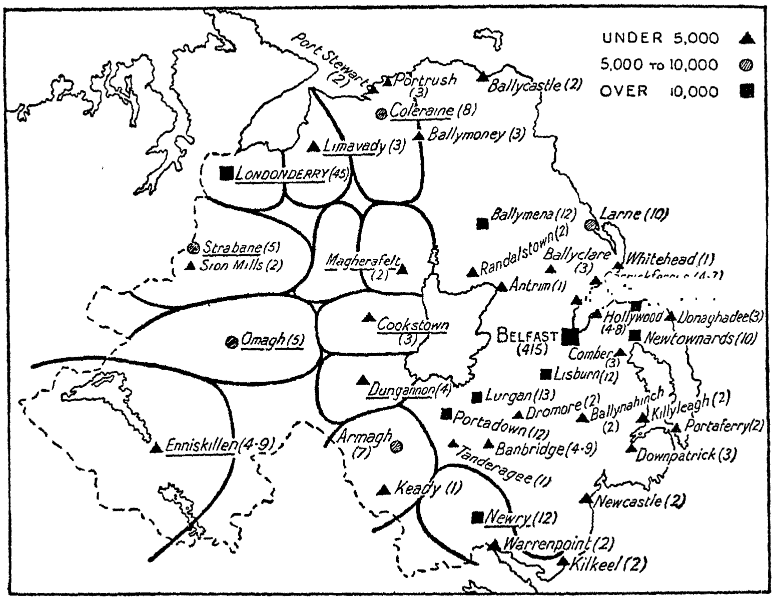

FIG. 131.—The market towns of Northern Ireland.

The population of each town is indicated to the nearest thousand. In the west the large area served by the market town (underlined in each case) is shown by the heavy lines. Scale, roughly 30 miles to 1 inch.

whilst on the poorer soils east of the Lough potatoes are more important. This region is the great area of flax cultivation which is particularly important in the valley of the Main. A basalt ridge separates the Main and lower Bann valleys, and rises to over 500 feet. This is sufficient to render cultivation unimportant, and to bring in sheep pastures. Otherwise sheep are unimportant in the basin itself. In the broad lower Bann Valley, centring on the small port of Coleraine, mixed farming is typical.

The Mountains of Londonderry and Tyrone.—Geologically this area is part of the ancient massif of Donegal from which it is separated by the broad fertile valley of the Foyle. The highest parts form

the Sperrin Mountains, rising to 2,240 feet, whilst near at hand is to be found the high western edge of the basalt plateau. The higher areas of both the basalt and the ancient rocks are unoccupied save for a few sheep ; towns and large villages are absent over the greater part of the area, the inhabitants being found in small isolated farms in the valleys. Here the valley farmers have a few cattle and a few pigs, and succeed in growing crops of potatoes and turnips—perhaps some oats; but other crops are unimportant. The valleys open out westwards into the Foyle Valley.

The Foyle Valley and the Shores of Lough Foyle.—The significance of this corridor connecting the lowlands of central Ireland with the port of Londonderry has already been stressed. It is sheltered from the rain-bearing westerly winds ; there is much arable land devoted especially to oats and to a much smaller extent to

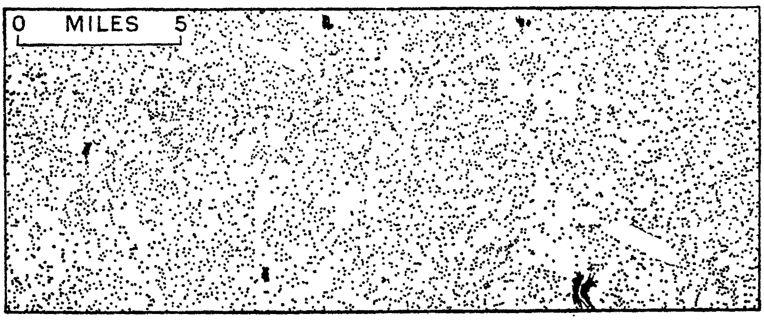

FIG. 132.—Map indicating the scattered nature of rural settlements in Ireland. Each dot represents a single inhabited house, but there are only five villages in the whole area. T[illegible] is Newry.

potatoes and turnips. As a result of this cultivation, the area of cultivated land in County Derry almost balances the area under permanent grass. The Foyle Valley has already been likened to a Scottish strath. In its continuation north-eastwards along the southern shores of Lough Foyle there is a wide stretch of marine alluvium largely given over to cattle pastures, and further inland a belt of lowland floored by red Keuper Marls which give good arable land, and which may therefore be said to correspond roughly to a Scottish carse.

The Rift Valley Lowlands.—To the south-west of Lough Neagh there is a corridor of lowland which connects the Lough Neagh basin with the Central Plain in the Irish Free State. It lies between the ancient metamorphic rocks of the Sperrin Mountains on the north, and the Ordovician-Silurian sediments on the south. Structurally it is, of course, a continuation of the Rift Valley, or Midland Valley, of Scotland. As in the Midland Valley of Scotland, there are large

tracts of Old Red Sandstone which give rise to an extensive hilly region east of Lower Lough Erne. As in Scotland, too, there are Carboniferous sandstones and shales giving rise to an area of hills to the north-east of Upper Lough Erne. The remaining area consists largely of Carboniferous Limestone worn to a lower level and masked by glacial deposits, as in the ill-drained tracts of the Central Plain. This forms hummocky lowlands with the hollows frequently occupied by shallow, tortuous-sided lakes. The region includes the greater part of Fermanagh, the southern portion of Tyrone and Derry, the main centre of the area being Enniskillen between Upper and Lower Lough Erne. Where this corridor links with the corridor of the Foyle Valley is the town of Omagh, whilst Armagh is on the southern fringe of the area. It is on the whole a region of small scattered farmsteads, whilst here and there only are there tiny market towns such as Aughnacloy. Dairy cattle are numerous, pigs comparatively few. Potatoes form a leading crop; oats are grown only in more favoured tracts.

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CHAPTER XIV

THE BRITISH FISHERIES

In round figures the fisheries of the United Kingdom employ about 80,000 men, or in all give employment to double that number of people, so that, with dependants, approximately half a million of the population of the country depend upon this industry. The annual catch is about a million tons, having an average value in post-1919 years of between 18 and 20 million pounds sterling. These figures may be compared with those given for mining and the agricultural industries of Britain, and it will be seen that the value of the fish caught is approximately one-tenth of the produce of the mines, or one-twelfth of the value of the produce of the farms.[1] So far as sea fishing is concerned, the British fisheries are possibly the most highly organised in the world, with the possible single exception of Japan. No country has so great a fleet of such large and powerful steam vessels for deep-sea fishing. On the other hand, the inland and freshwater fisheries are comparatively unimportant, with the exception of salmon, which are still exploited commercially, especially in the rivers of Scotland and Ireland. River fishing in Britain is now mainly reserved for sport and recreation, whilst the waters of many a once-famous salmon or trout stream have become polluted and almost devoid of fish.

"Wet" fish, as distinct from shell-fish, fall into two main classes—pelagic and demersal. Pelagic fish, literally "ocean" fish, are those which live in the surface waters, feeding there on the immense numbers of plankton or tiny organisms, the abundance or otherwise of which determines to a very large extent the size and the numbers of the fish. Pelagic fish tend to occur in large numbers or shoals, and by far the most important in the British fisheries is the herring. Others of importance are the pilchard and the mackerel. Although they are free swimming, these pelagic fish are by no means independent of the depth of the water or the character of the bottom, for they spawn on the floor of the sea. Demersal fish, known to the trade as "white" fish, are fish normally found feeding at the bottom of the sea, including both flat fish such as plaice and sole as well as free swimming fish such as cod and haddock. In pre-1914 years, owing to the enormous importance

[1] Number employed in fishing industry, 1921: England and Wales, 38,577; Scotland, 30,762; Ireland, 13,608. In 1930 Great Britain, about 60,000.

of the herring, roughly equal quantities of pelagic and demersal fish were landed at ports in the British Isles, although the value of the demersal was roughly double that of the pelagic. In post-war years both the quantity and value of the demersal fish have been relatively much greater than those of the pelagic. The attached table shows the quantity and value of the two main types of fish of British taking landed at ports in England and Wales in recent years.

	Demersal		Pelagic		Total wet fish	
	Quantity cwts.	Value £	Quantity cwts.	Value £	Quantity cwts.	Value £
1925	9,287,404	11,956,516	4,246,575	2,263,299	13,537,475	14,224,682
1926	8,556,946	10,936,606	3,943,449	1,758,686	12,504,138	12,700,657
1930	11,454,125	12,072,222	4,221,109	2,067,382	15,677,628	14,143,301
1931	11,109,473	11,181,689	3,503,615	1,020,212	14,616,118	12,206,040
1932	11,143,727	10,306,001	2,612,619	1,011,812	13,756,346	11,317,813
1933	10,941,278	10,186,857	2,722,148	1,002,814	13,663,426	11,189,671
1934	10,920,390	11,060,675	2,654,533	899,009	13,574,923	11,959,684
1935	11,396,644	10,954.251	2,950,730	1,001,952	14,347,374	11,956,203

Totals for Scotland were: 1925, £4,454,168; 1926, £4,349,205; 1927, £4,369,968; 1928, £4,658,100; 1929, £4,672,916; 1930, £4,177,775; 1931, £3,661,982; 1932, £3,711,104; 1933, £3,519,795; 1934, £3,544,211; 1935, £3,852,112; 1936, £5,064,782; 1937, £4,701,657. England and Wales: 1937, 17,034,722 cwt. (£11,932,690).

Although the fishing grounds visited by British vessels and from which fish are landed at British ports extend from Iceland on the north to Morocco on the south, and from the Barents Sea on the east to the west of Scotland, Rockall, and the south-west of Ireland, it is the character of the Continental Shelf surrounding the British Isles themselves which must be regarded as in the main responsible for the rise to importance of the British fishing industry. Approximately two-thirds by weight of the fish landed in England and Wales are caught by the trawl, which can only be used in shallow water. There is no trawling at a greater depth than 250 fathoms, that is 1,500 feet, and very little at a greater depth than 200 fathoms or 1,200 feet, whilst a great deal of the trawling is carried out in water very much shallower than this. It will, therefore, be an advantage to study the submarine contours round the British Isles and to see what limits these place on the possible fishing grounds. It will be seen that the British Isles rest on a broad Continental Shelf and are entirely surrounded by shallow water, as are Iceland, the Faeroes, and Rockall. The North Sea, except for a deep channel off the coast of Norway, is everywhere less than 100 fathoms in depth. The northern part is 40–100 fathoms, but the southern half is everywhere less than 50 fathoms or 300 feet. There is thus in the North Sea, on the whole, a gradual decrease in depth from north to south; but this gradual shallowing is interrupted by numerous banks and deeper depressions called pits. The largest and most important of the banks is the well known Dogger Bank

which, with an area of something like 7,000 square miles, is covered by water only 10–20 fathoms deep. Not only do these shallow seas with their sandy or rock-free floors afford excellent fishing grounds where the trawl net can be used to the greatest advantage, but they also provide spawning and breeding grounds which are obviously essential to the maintenance of the supply of fish. Further, there is that absence of stagnation and monotony of conditions which might prove fatal. There is the movement of the tides round the British Isles and the warm drift of water from

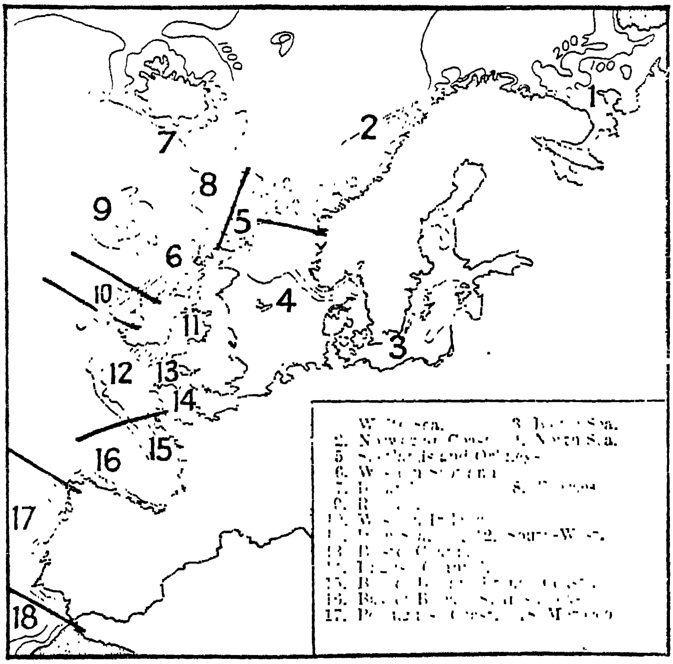


FIG. 133.—The main Fishing Grounds used by British fishermen. Depths are shown in metres.

the North Atlantic Drift, the seasonal variations in temperature, salinity, and the character of the bottom deposits which give the necessary variation of conditions for the different species of fish or to the same species of fish at different stages of development. The fish must depend ultimately for their supply of food on plankton. Plankton consist of (*a*) minute plants, particularly diatoms and algæ, which like land plants are capable under the influence of light of transforming inorganic substances into organic material, thus rendering it available as fish food, together with (*b*) enormous numbers of small sea animals, such as small crustacea, hydrozoa, foraminifera, mollusca, etc., whilst together with the whole mass are huge

quantities of the spawn of demersal fish. Indeed it is the spawn of the demersal fish which suffer particularly from a paucity of plankton foodstuffs. A paucity of plankton means a heavy mortality amongst fish spawn, the effect of which will not be felt as far as the fisheries are concerned until some years later.

A map has been included to show the main fishing grounds from which landings of fish are provided for British ports. Each fishing boat, on arriving in port, is compelled to declare, not only the type of fish caught, but the area from which the fish has been obtained. For purposes of classification the Ministry of Agriculture and Fisheries has distinguished somewhat arbitrarily the fishing grounds which are marked on the map. As might be thought, easily the most important area is the North Sea, followed by the very important Iceland area, then by the south-western tract off the south of Ireland, and then by the Faeroes, the west of Scotland, and the English Channel. Before examining the characteristic fish found of each of these areas it will be necessary to analyse the different types of fish landed.

TABLE SHOWING THE VARIOUS FISH OF BRITISH TAKING LANDED AT BRITISH PORTS, 1937

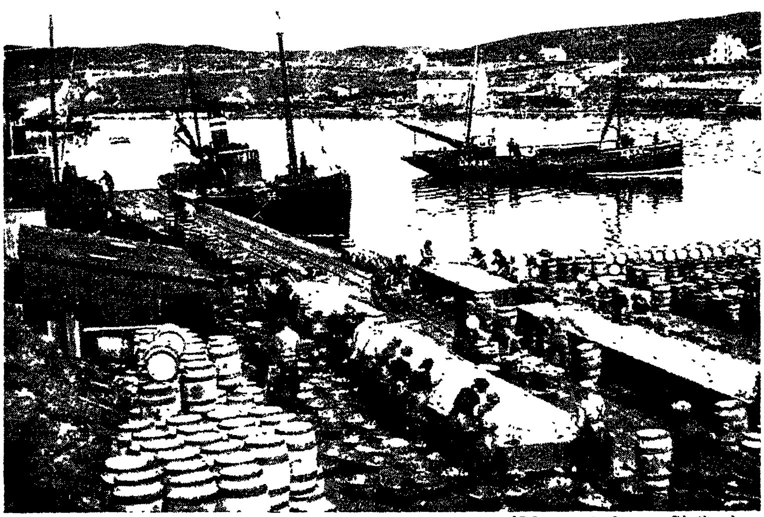
Total weight landed at English, Welsh, and Scottish Ports (in thousands of cwts.)

Demersal Fish—		*Pelagic Fish—*	
Prime fish—		Herring	5,563
Brill	18	Mackerel	179
Sole	75	Pilchard	69
Turbot	71	Sprats	150
Cod	7,513	All others (demersal and pelagic	1,838
Haddock	2,979		
Whiting	495		
Hake	601	Total fish (excluding shell-fish)	21,807
Halibut	120		
Plaice	599		
Skate and Ray	429	Value, £15,394,017.	
Dogfish	201	(Value of herring, £2,196,303.)	
Coalfish	664	Shellfish, £540,346.	
Catfish	243		

This table is at first very surprising, because it illustrates the fact that the fish which are most popular and best known on the British table or in British restaurants are actually landed in comparatively small quantities. This is partly because of the very large quantities of herring and cod and certain other fish which are absorbed by the export trade. Many of the fish with less familiar names are utilised by fried fish shops. Returning now to the map of British fisheries we find that, taking the fish mentioned in the above table, in order, they have certain characteristic features of distribution. The herring is characteristically, one might almost

say, exclusively, a North Sea fish. With the exception of the English Channel, southern Ireland, and the Bristol Channel, landings from other areas are small. Of other pelagic fish the once important pilchard has now almost disappeared. It is and always has been essentially a fish of the south-west of England, of the western part of the English Channel, and of the south of Ireland. The mackerel is again a southern fish, particularly important in the English Channel and the Bristol Channel.

Turning to demersal fish, the cod is, of course, primarily a fish of cold northern waters. Something like half the catch is in the



[*Photo: Anderson, Shetland.*

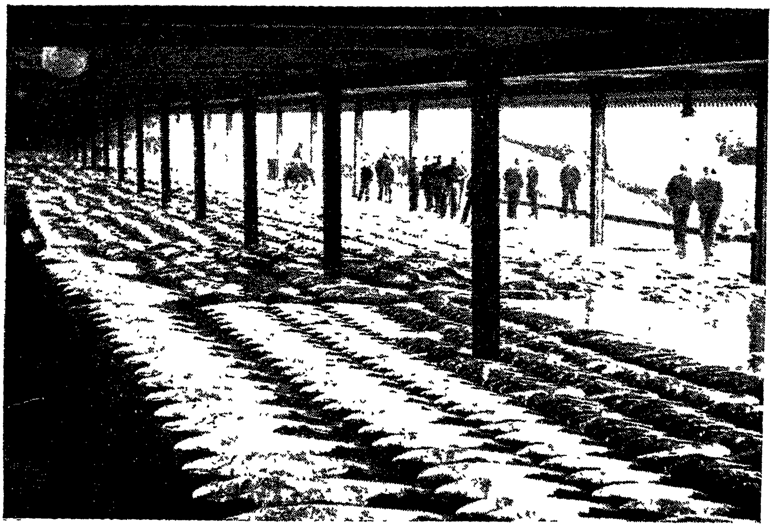
FIG. 134.—Lerwick, Shetland, at the height of the herring season.

The three types of herring fishing vessels are shown—the steam drifter, the sailing-auxiliary motor vessel and, just visible in the background on the left, a sailing vessel.

cold Icelandic fisheries, and the quantity decreases as one comes southwards. The haddock is the predominant catch in the northern, deeper part of the North Sea. Halibut is still more a northern type, the really large catches being mainly restricted to Icelandic waters. Hake is unimportant in the North Sea, but is the chief fish of the south-western area in the relatively deep trawling ground to the south of Ireland. Skate and sole are likewise the fish of the western side of England. Of the better-known flat-fish the plaice has the widest range. Landings from the far-distant Barents Sea area are important, but the popularity of the fish has given rise to anxiety

because of the decrease in quantities which have been found in the northern sea. The plaice and still more the sole are really the reason for the operation of British vessels in the more distant fisheries. The lemon sole and the widely appreciated turbot have never formed large percentages of the total landings. It is the harvest of soles which tempts the British fisherman to leave the North Sea and the Bristol Channel for the far-away Moroccan waters.

Only in the last half-century the British fishing industry has undergone a complete change. This may be summed up in the two words "centralisation" and "industrialisation." It is a



[*Courtesy of the London and North Eastern Railway.*

FIG. 135.—The Aberdeen Fish Market, with fish laid out for sale by auction.

commonplace of history that the British fishing grounds form a nursery for the seamen of both our Navy and our Merchant Navy. Almost every cove on the rock-girt coast of the west has its little break-water, its little quota of fishing-vessels, and nestling in the sheltered valley behind, a little fishing village. The same is true of the sandy estuaries and coves along the eastern coast. In the days of the Armada these fishing villages provided the bulk of the sailors for the British Navy. The little old town of Fowey in Cornwall is proud of having provided no less than 47 ships for Edward III's navy for the siege of Calais, compared with London's 25. Less than 5 per cent. of the fish now landed in the British Isles is landed at these small old fishing villages. Some of them, such as St. Ives, Mevagissey or, to use its popular local name, "Fishygissy," and

Brixham, choosing examples from the south-western peninsula, have done their utmost to fight the uneven fight against the octopus of the large railway fishing port. Others have discovered that there is a market value in picturesqueness, and have come to rely for much of their revenue on their summer visitors. The fisherman hires out his boats for the summer months, while his wife provides board and lodging for the visitors. But unless the visitors' own skill is above the average he probably finds that his stay at the seaside is marred by an absence of "fresh fish on the table." It is the advent of the steam trawler and the steam drifter which is in the main responsible for the great change.

The majority of the herrings and other pelagic fish are caught from the drifters and the majority of demersal or white fish from the trawlers. The drift-net carried by the drifters is lightly and strongly made of cotton, and each net measures from 50 to 60 yards long and about 13 yards deep, but the nets are used in a "fleet" or series, so that sometimes as many as eighty are employed at one time in one vessel, to form an extended wall of netting hanging perpendicularly in the water. There is a headline kept floating on the surface by a series of buoys or "pellets" and the top of the net is usually about three yards below the surface, being connected with the headline by a series of ropes called strops. The net or nets are attached to the floating buoy or to the drifting ship itself, hence the name "drifter," and move with the buoy or ship under the influence of wind and tide. The net is arranged to intercept fish of the right size which attempt to pass through and are caught by the gills. Thus drift-nets are of different gauge according to the fish it is proposed to catch. Those for herring have an inch mesh, a smaller size are the drift-nets used for catching sprats, while drift-nets of a larger size are used elsewhere for catching salmon. A number of wooden drifters are still in existence and some are still being built, but the majority are of steel. Most of the British drifters are about the same size, having a gross tonnage of 95 and a length of 85½ feet, and a beam of 18½ feet, carrying a crew of seven men and a boy.

The most important method of fishing demersal fish is by trawling. The trawl-net is a bag-shaped net, the mouth of which is kept open either by a beam across the head or by pressure of the water upon wooden kites known as trawl-boards attached to the net. The trawl-net is dragged along or near the bottom of the sea. The beam-trawl is still used on fishing smacks and small vessels, but the strange contraption known as the "kite" is used entirely on steam trawlers. The steam trawlers built in Britain since the War tend to conform closely to three types: the "Mersey" type is the largest and is generally used for fishing in distant waters such as Iceland and the northern coasts. Provision can easily be

made for the absence of the vessel for at least a month from its port. This type has a gross tonnage of about 324 tons, and a length of 138 feet. The "Castle" type is smaller with a tonnage of 275 and a length of about 125 feet, and is mainly used for the Atlantic fisheries, such as those for hake; whilst the smallest of the three types, the "Strath," is that most extensively used in the North Sea, and has a tonnage of 215 and a length of 115 feet. There is a distinct tendency for the size and power of vessels used in trawl-fishing to increase.[1] There are a few subsidiary but still important methods for fishing employed in the British fisheries. One is fishing by line—a line of baited hooks. This is mainly used by Scottish fishermen in the northern part of the North Sea. The other method is that of the Danish *Seine* net. Fishing by this net was perfected by the Danes during the War and its adoption to any considerable extent in England only dates from 1921, and it was the direct result of Danish boats putting into British ports and British fishermen having evidence placed before them of the efficiency of a new method. The trawler actually drags the net along the bottom, but in this method of fishing the vessel remains stationary whilst the bag-shaped net is at the centre of a very long haulage line and is gradually hauled in by a motor-engine on the vessel, there being an arrangement of ropes in front of the net in such a way that they rather disturb the fish lying in the path of the net and cause them to move in such a way as to get caught. Lining is mainly used for large fish, particularly cod and halibut, and the baits used vary according to the season—mussels, whelks, small herring, etc.

The table given on the following page shows the quantities of fish caught by each of the principal methods and landed at British ports.

Although the trawl-net has been in use in British fisheries for something like 250 years, until 1870 it was in the form of the beam-trawl and was operated exclusively by sailing-vessels. The sailing-vessels could not be absent more than a few days from port; they were largely dependent upon weather conditions; the radius within which they could fish was distinctly limited. Of necessity they landed their fish at the nearest available port, probably their home-port. Steam-power was first introduced in the form of tugs, which assisted these fishing-vessels, but the gradual evolution of the steam trawler has followed. It is interesting to notice that these trawlers are built at special shipbuilding yards, not as a rule at the ordinary shipbuilding centres. A very large number are either built or assembled at ports surrounding the Humber, such as Beverley, Goole and Selby (cf. p. 388).

[1] But this tendency may be reversed by the adoption of fast motor-boats requiring only a very small crew.

QUANTITY OF WET FISH OF BRITISH TAKING LANDED

	1913 cwts.	1921–25 (average) cwts.	1926–30 (average) cwts.	1931 cwts.
1st class—				
Trawl, steam . . .	7,991,404	7,665,800	8,868,334	10,559,721
,, motor . . .	909	21,483	24,594	35,739
,, sail . . .	418,269	165,600	127,850	75,970
Total . . .	8,410,582	7,852,883	9,020,778	10,671,430
Lines, steam . . .	281,185	360,584	301,001	305,594
,, motor . . .	14,886	50,896	93,102	111,439
,, sail	18,720	—	—	—
Total . . .	314,791	411,480	394,103	417,033
Danish seine, steam .	—	287,097	160,724	73,263
,, motor .	—	7,570	6,564	10,455
Total	—	294,667	167,288	83,718
Drift, steam . . .	6,402,729	3,020,433	3,551,427	2,901,974
,, motor . . .	209,296	346,866	275,069	172,943
,, sail	306,784	340	69	77
Total	6,918,809	3,367,639	3,826,565	3,074,994
Other methods and methods not known	17,051	22,906	24,472	24,068
2nd and 3rd class, and from shore . . .	464,202	463,488	364,892	344,875

The "Mersey" type of trawler will probably be absent for as much as a month, the longest duration of voyages for ships fishing in the waters round Iceland being just over three weeks. They have a bunker capacity for something like 250 tons of coal. They are usually built in such a way that the engines, the bunkers, the captain's, and the engineer's quarters are in the after half of the vessel, the crew's quarters amidships, while forward there is a small reserve bunker and the main fish-bunker, capable of taking 60 tons of fish. The main fish-bunker is divided into partitions by means of movable boards, and on the outward journey as much as 50 tons of ice may be taken. The North Sea type of trawler, the "Strath," is naturally smaller; it is likely to be absent from three to six days, so that a large storage capacity for fuel, ice, and fish are not required. Obviously these steam vessels can only land their catch where there are good facilities for handling large quantities and for rapid dispatch to centres of consumption. The tendency of the fishing industry to concentrate on a few specialised ports is further increased by the recent tendency to transfer at sea the fish from the smaller

drifters and the smaller trawlers to large fast vessels acting as carriers.

The next map (Fig. 136) will show at a glance the principal fishing ports of Great Britain. Against each of the ports there

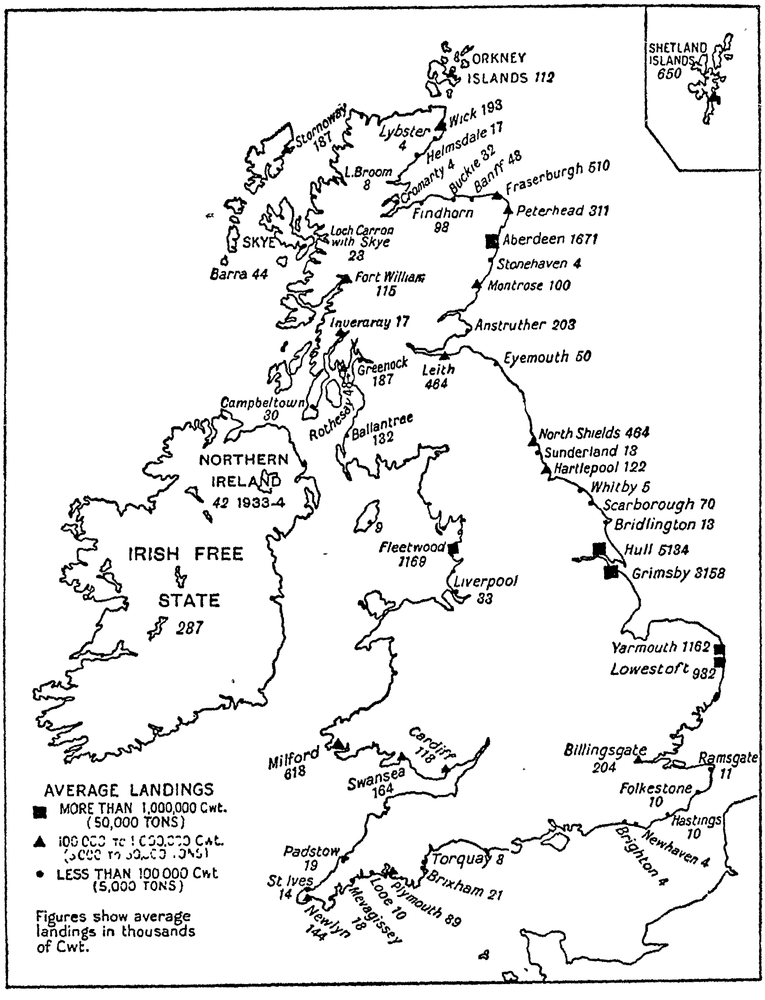


FIG. 136.—The fishing ports of Great Britain.
Figures are average landings for the years 1934–35.
Important Note: The names refer to fishing *districts*. In some cases, *e.g.* Montrose, much of the actual landing is at a neighbouring unnamed port (*e.g.* Dundee).

have been shown the average landings. It will be seen how from the modern industry there have disappeared once important fishing ports such as Stornoway in the Outer Hebrides and Lerwick in

Shetland. The industry is now concentrated on five of the ports on the east coast of Britain and one, Fleetwood, on the west coast.

This map shows that not only is there a concentration of the British fishing industry at certain leading ports, but that there is a distinct specialisation at each of the ports. Those that have the largest landings of pelagic fish, *i.e.* mainly herring, often show a comparatively small importance in relation to demersal fish and *vice versa.* The reason for this will be apparent if we make a brief study of the herring industry. An outstanding feature of the herring industry is the large proportion of the catch which is destined for export. Before the War as much as 75 per cent. of the total catch was actually exported, mainly to the Baltic countries and Russia. Naturally, the War disorganised this trade, and the post-war disorganisation of Russia is in a large measure responsible for its slow rejuvenation. Even so, at the present time something like 30 per cent. of the herrings are exported. Of the remainder, a comparatively small proportion is destined for consumption in this country as fresh herrings, more being destined for home consumption as bloaters and kippers. Thus, in the case of herrings, when they are landed there is not usually the need for rapid distribution to consuming centres that there is in the case of demersal fish. Instead, there must be provision for the salting of the herrings in barrels, and often the manufacture of the barrels themselves takes place, as at Yarmouth, near the actual landing-places of the fish. Bloaters are herrings which have been lightly smoked; kippers are herrings which have been cut open and gutted and smoked, usually with the help of a wood-fire. The lightly-smoked bloaters do not keep so long as the kippers, but at the same time there is not the need for haste in their distribution to markets and consuming centres.

Turning to the list of the great herring ports of Scotland we find, in order, Frazerburgh and Peterhead, to the north of Aberdeen, not nearly so conveniently situated relative to rail transport as Aberdeen itself. Then there is Wick in Caithness, too far to the north of the country to be suitably situated for the landing of demersal fish. Of the three herring ports on islands, Stornoway in the Outer Hebrides, Stromness in Orkney, and Lerwick in Shetland have practically no trade in demersal fish for British markets. In England, Yarmouth is pre-eminently the herring port, with Lowestoft a good second, landings at other ports being comparatively small. The second interesting feature about the herring industry is its seasonal character. The fishing starts about June in the north and terminates about October or November in the south at Yarmouth. It is a mistake to think that the fish themselves migrate southwards. The herring fishing in Devon and Cornwall is still later, though not an important amount, being in December. It

would seem that the time of spawning of the herring is determined by the physical conditions of the water, and takes place much earlier in the north than in the south, so that the herring are ready for catching earlier in the north than in the south. Although the herring themselves do not migrate southwards, the fishing boats to a very large extent do, and so also do the Scottish fisher-girls who are engaged in cleaning the fish and packing them in barrels or preparing them for kippers and bloaters when they are landed.

During the season as many as a thousand boats may be out from Yarmouth, and a day's catch may be 4,000 tons, or three-quarters of a herring for every man, woman, and child in the British

[*Photo : L. D. Stamp.*

FIG. 137.—A wreck on the northern shores of Scotland.

The Pentland Firth, between John o' Groats and the Orkney Islands, is one of the most treacherous tracts of water in the world.

Isles. Although nutritively far more valuable than equal quantities of white fish, the herring, probably because of its commonness and cheapness, is not fully appreciated in this country. It is not, indeed, appreciated nearly as much as it should be.

After being cleaned the herrings for export are packed in barrels of alternating layers of salt and fish. Some of the brine is drained off before the barrels are sealed for export. Amongst the continental ports taking large quantities of Scottish and English herrings may be mentioned Danzig, Hamburg, Stettin, and other ports of Northern Germany, Riga, Revel, Memel, and other ports in the Baltic.

Turning now to demersal fish, the overwhelming importance of

the Humber ports Hull and Grimsby in England, paralleled to some extent by Fleetwood on the west coast, and Aberdeen in Scotland, is at once apparent. There is an important trade in the buying and salting of cod for export, particularly to southern Europe and other Roman Catholic countries, but the bulk of the remainder of the demersal fish is destined for home consumption. Whilst it keeps comparatively well with the help of salt at the even temperature in the holds of the vessels from which it has been caught, as soon as the fish is landed deterioration is rapid. Though a process of freezing fish in brine has now been perfected, the process is expensive and if possible must, therefore, be avoided. Further, although it does not destroy the nutritive value of the fish it sometimes tends to destroy the flavour. Thus there is evidence at once of the necessity of very rapid handling as soon as the fish can be landed. Hence the very specialised type of water-side accommodation, railway sidings by the wharf, special fish expresses running during the night and reaching the great markets, such as London, in the early hours of the morning. The great fishing ports are, in other words, the creation of the railways. An excellent example of what facilities and handling and transport mean to the fish trade is afforded by Fleetwood. A few years ago Fleetwood had a small passenger traffic to Ireland. The London, Midland, and Scottish Railway quite definitely decided on the policy of abandoning the passenger traffic and of concentrating all their attention on improving the facilities for the landing and the handling of fish. The result is seen at once in the figures: in 1913 Fleetwood handled 745,632 cwt. of fish; in 1935 it handled 1,230,000 cwt. Now Fleetwood may be said to attract fishing vessels from right away to the south of Ireland, and as far as Rockall to the north-west of Scotland, merely because of the facilities which have been provided for rapid handling. The specialised organisation of some of the fish-markets, including that of Billingsgate, will be noticed later. It should be mentioned that fishing for demersal fish is not seasonal in character like that for herrings, but takes place throughout the year.

The trade in fish and fish-products of the United Kingdom is interesting. The bare figures are given in the table below:

	1927 tons	1928 tons	1929 tons	1931 tons	1935 tons
Imports (fresh, cured, canned)	242,000	273,000	263,000	229,000	194,000
Exports of United Kingdom produce (fresh, cured, salted, canned)	384,000	385,000	414,000	272,000	229,000
Exports of United Kingdom (cured or canned herrings only)	274,000	279,000	302,000	184,000	—
Re-exports (cured or canned fish of foreign and colonial origin)	19,000	24,000	23,000	15,000	8,000

The bulk of the exports is represented by herring and cod, a very large proportion of the imports by canned salmon and sardines. There is no adequate home supply to take the place of the fish which is thus at present imported, but the very large important consumption of canned fish is worth while noticing in connection with a possible development of the fish-canning industry, that is, the canning of certain types of British fish. In the consideration of the canning industry given in Chapter X it was noticed that one of the outstanding difficulties was that fruit and vegetables are both strictly seasonal, and it is difficult to arrange for continuous work for a canning factory throughout the year. The canning of British fish might obviate, at any rate to some extent, this difficulty.

Provisions for fishery research is made by the Ministry of Agriculture and Fisheries for England and Wales, and by the Fishery Board for Scotland. No historian needs to be reminded of the consequences of the medieval migration of the herrings when they left the Baltic Sea, and this should be a reminder that the habits and peculiarities of fish should be watched and understood. Despite the fact that fish are extraordinarily prolific creatures the fishing year after year must of necessity tend to deplete the fisheries. That this has happened and is happening is quite evident from the figures of North Sea catches. It is evident in another way. During the War the North Sea fisheries had a considerable, almost a complete, rest, and when fishing recommenced in 1919 the hauls were remarkable for their size, but in the next two or three years rapidly dropped again. This shows the effect of resting a fishery. Much can be done, too, by hatching out spawn and then distributing the young fish in suitable places on the sea bottom. Much hatching of spawn, of course, is now carried out in the salmon fisheries of North America. A peculiar position arises with regard to soles and plaice in the North Sea, which spawn in the southern part of the North Sea, and possibly owing to drifting currents the young fish find their way north-eastwards towards the coast of Denmark. It would seem that they are unable, owing to intervening deeper water, to reach the more suitable feeding grounds which are on the Dogger Bank. If these spawn or young fish can be taken and transported and dropped on the Dogger Bank it is found that they grow with most amazing rapidity. This is quoted as one example of what may be done towards the maintenance or development of British fisheries. Amongst the institutions for studying these problems may be mentioned the Marine Biological Institution of Plymouth.

It remains now to deal with what are usually called shell-fish,[1] despite the fact that they are biologically unconnected with fish at all. By far the most important shell-fish are, of course, oysters.

[1] Average annual value, 1928–1937, roughly £500,000.

The great oyster beds for which Britain has so long been famous are concentrated on either side of the mouth of the Thames, and particularly on the mudflats off Whitstable and to the north on the mudflats off Essex, near Colchester. The fishing is seasonal, and the opening of the fishing season is usually celebrated by some picturesque ceremony, the mayor of the town eating the first oyster. The oysters are dredged from shallow water, the immature oysters being returned to the oyster beds. Mussels occur widely round the coast and are consumed in small quantities, as are also cockles and winkles. Of the crustaceans which are caught for human consumption the shrimps favour shallow water and are caught in huge numbers in the Wash. Prawns are more local in their distribution, and in some seasons there is a considerable import. Lobsters favour the rocky coasts of the south-west, and lobster fisheries remain important and profitable in some of those small fishing villages where the fishing for demersal fish and for pelagic fish would seem almost forgotten. Lobster pots, for example, are common sights in many of the Cornish villages. Lobsters are very important also in the Orkneys and at Stornoway in the Hebrides. Crabs come particularly from Flamborough, Beadnell (Northumberland), and Scarborough.

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CHAPTER XV

COAL

THE value of the output of the mining industries of the United Kingdom, relative to the other great branches of industry, has already been given, and of recent years the coal mining industry has been too much before the public eye, for it to be necessary to stress its importance in this country. What is not always realised, however, is the overwhelming pre-eminence of coal amongst British minerals as a whole. Taking the average of the years 1927–29, before the great depression of 1931–35, and after the great coal strike of 1926, it will be seen that coal represents 88 per cent. by value of all the mineral products of the United Kingdom, whilst the next mineral in importance, iron ore, only represents about 1·7 per cent. Britain has ceased to be to any degree a producer of metallic minerals other than iron; all the other minerals of which the annual value is over £1,000,000 are non-metallic. Of the metalliferous minerals for which Britain was once famous tin ore and lead ore are the only ones of any considerable value.

Mineral	Quantity in tons 1931–35	Value in £ sterling
Coal	215,600,000	141,487,000
Iron ore	8,780,000	1,928,000
Limestone	13,939,000	2,922,000
Igneous rock	9,798,000	3,038,800
Slate	272,000	1,588,000
Sandstone	4,115,000	1,576,000
Salt	2,330,000	1,051,000
Clay [1]	19,057,000	1,679,200
China clay	811,000	881,400
Fireclay	1,856,000	620,000
Gravel and sand	11,990,000	1,782,000
Oil shale	1,461,000	414,800
Tin ore	2,500	253,800
Chalk	—	} 1,561,000
All others	—	
Total	—	160,783,000 [2]

The same predominating importance of coal mining is borne out if one considers the employment figures. The following table shows

[1] Clay, shale, etc. [2] Total value in £mn.: 1936, £183; 1937, £209 (coal, £183).

the number employed in the principal branches of the mining industry of the United Kingdom in recent years :

NUMBER OF PERSONS EMPLOYED AT MINES AND QUARRIES
(According to the Mineral obtained)

	1927	1929	1931	1932	1933	1934	1935
Coal . . .	1,023,886	956,674	867,864	819,324	789,091	788,201	769,474
Iron ore and Ironstone .	11,864	12,884	7,742	7,017	6,675	7,981	7,981
Non-ferrous Metalliferous ores	5,137	4,904	1,380	1,565	2,021	3,270	3,409
Other minerals	97,399	95,040	85,866	78,805	78,039	82,245	84,100

Previous to the great depression the coal production in round figures of the United Kingdom was 250,000,000 tons per annum. This may be compared with a world production of about 1,500,000,000 tons. Thus this country is responsible for the production of one-sixth of all the coal mined in the world. The United States, the world's largest producer, is responsible for about 500,000,000 tons, or a third of the total; whilst third in order of production comes Germany with, in very round figures, 200,000,000 tons. Thus the three great producers, the United States, the United Kingdom, and Germany, between them produce nearly two-thirds of the world's coal. But the two diagrams here reproduced illustrate two most important facts. One is that from pre-1914 years there has been a comparatively slight but actual rise in the total world output of coal. This increase in world output has been caused by the development of coalfields in new areas or in the smaller countries, and so affords an explanation of the second diagram showing the fluctuations in the British production from the early years of the present century. Britain is really unique amongst the countries of the world, in the first place in having (in comparison with its area) this enormous

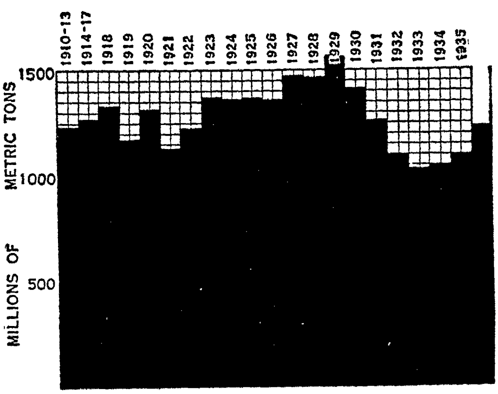


FIG. 138.—Graph showing the world's coal production in recent years.

Notice the general tendency (previous to the great depression) to a general rise.

production of coal, and in the second place in depending upon the export trade for the disposal of approximately, referring that is to recent years, one-quarter of it. Clearly, the development of production in "newer" countries of the world, the increased development of hydro-electric power resources, and perhaps still more the enormous increase in the world use of oil have combined to render it very difficult, if not impossible, to maintain the pre-war markets for British coal. We cannot draw parallels between this country and other producers. Our position is unique, and we must work

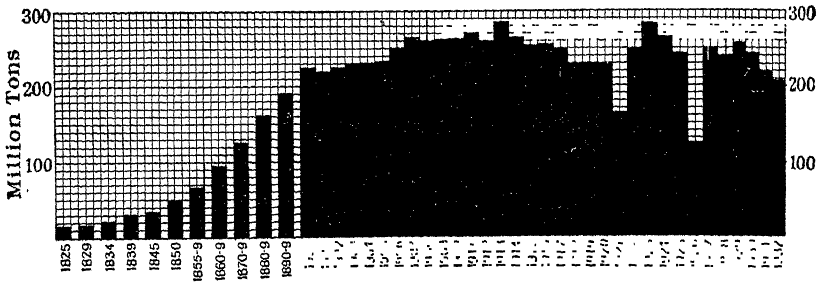


FIG. 139.—Graph showing the coal production of the British Isles.

Notice that the very low productions in the great strike years of 1921 and 1926 are *not* reflected in the wor [illegible], showing that other countries took advantage of the industrial [illegible] production in million tons: 1933, 207; 1934, 221; 1935, 222; 1936, 228; 1937, 240; [illegible].

out our own salvation. The troubles in the British coal industry in recent years seem to have given rise to a widespread, though entirely erroneous idea, namely, that the coal reserves of the British Isles are becoming exhausted. This is very far indeed from the truth. There is known to be enough coal to last for at least five centuries at the present rate of consumption. Taking into account probable reserves and possible new extensions of existing fields, the quantity existing is enough to last seven centuries.[1]

RESERVES OF BRITISH COALFIELDS

Authority and date of estimate	Estimated reserves in millions of tons			
	Actual proved	Probable and possible	Total	Still intact Jan. 1, 1933 on basis of estimate
First Royal Commission, 1871 .	90,207	56,273	146,480	133,350
Second Royal Commission, 1905 .	100,914	39,484	140,398	133,000
International Geological Congress (Sir Aubrey Strahan, 1912) .	133,117	45,610	178,727	173,000
H. S. Jevons, 1915	136,000	61,000	197,000	193,000

In seams of 1 foot and upwards in thickness, down to 4,000 feet in depth.

[1] Report of the Royal Commission on the Coal Industry, 1925. Command Paper 2600. 1926. H.M. Stationery Office.

THE DISPOSITION OF THE COALFIELDS

Unlike her neighbours on the Continent of Europe, Britain has practically no production nor resources of lignite or brown coal. The small field containing such coals of Tertiary age at Bovey Tracy in Devonshire is essentially unimportant. Britain's coals are nearly all of Carboniferous age; those of England and Wales occurring in the Coal Measures (Upper Carboniferous), those of Scotland in both the Lower and Upper Carboniferous. There is an isolated mine at Brora on the coast of Sutherland in northern Scotland which works coal of Jurassic age. Britain is perhaps unfortunate in that a former wide spread of Carboniferous rocks has

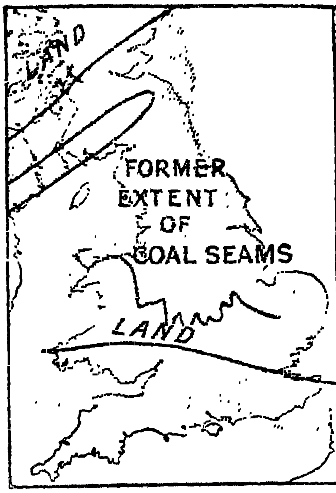


FIG. 140.—The geography of the Coal Measure period.

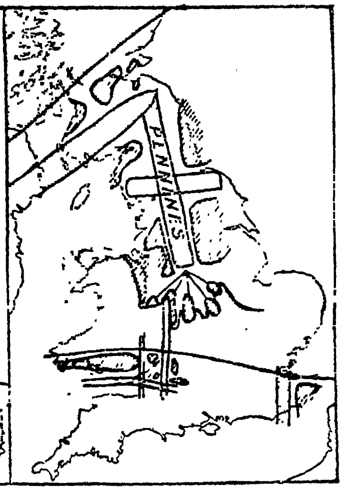


FIG. 141.—The effect of subsequent earth movements in separating the British Coal Measures into a number of basins.

been broken up into a number of separate small areas by subsequent earth movements and denudation; and an attempt to reconstruct the geography of the period may assist in the understanding of the disposition of existing fields.

In Chapter II we have already outlined the conditions under which the Coal Measures of Britain were deposited, and it has been indicated that the coal-bearing rocks must have stretched almost continuously from the borders of the Scottish Highlands to the heart of England.

At the close of the Coal Measure Period there occurred the Carbo-Permian, or Armorican, earth-building movements. In the British Isles two consequences of these movements were the erection of the

long anticlinal ridge of the Pennines from north to south, and probably also the early formation of an east–west upfold crossing it from the Lake District to north Yorkshire. Naturally the Coal Measures which had been deposited were removed by denudation from the upraised portions, and thus there occurred the separation of the British Coal Measures into the isolated basins in which they now are found. Similar earth movements caused the formation of the South Wales basin (shaped so much like a pie dish), and of the other isolated basins of the Forest of Dean, the Somerset and Bristol coalfield, and that in East Kent. During the Permian, the Triassic, and later periods the Coal Measures over much of the country were covered by a thick coating of later rocks. In some areas this later coating has been removed, in others it remains, so that one finds, for example, the Coal Measures of Durham plunging eastwards under a covering of later rocks belonging to the Permian and Triassic systems. The same is true of the great coalfield of Yorkshire, Nottinghamshire, and Derby, where the most important part of the whole field is this hidden portion. In East Kent, of course, one has the best example in this country of an entirely hidden coalfield. Later earth movements, after the deposition of the Coal Measures, were responsible too for the folding of the British Coal Measures and, perhaps more important, their fracturing by a series of faults. The folding was not nearly so severe as in many of the Continental fields, for example, Northern France and Belgium, and does not as a rule affect the quality of the coal. But the faults often have a very big throw, and seriously affect mining conditions.

The general broad classification of coal is into the four types—anthracite, bituminous or humic, semi-bituminous, and lignite or brown coal.[1] British coals belong to the first two groups. The production of anthracite is limited to the western part of the South Wales coalfield, and is now generally believed to be due to a difference in the constitution of the mother substance from which the coal has been formed. It is difficult to classify the bituminous or humic coals exactly according to their chemical composition, but a rough and ready, though well understood, classification is used for British coals. This classification is based upon their suitability for different purposes. Amongst the more outstanding types may be mentioned steam coals—hard coals which burn with comparatively little flame and comparatively little soot, and which are therefore much valued for factory use, for bunker purposes and for ships. Similar types of coal are appreciated for domestic purposes under the name of

[1] Peat is not considered in this chapter. As a fuel it is of great and wide importance in Ireland, many parts of the Highlands of Scotland, and in certain areas in England and Wales. But its use is mainly as a domestic fuel; so much is cut and dried by the consumers themselves that calculations of quantity and value of the annual production are impossible. See "Peat in the British Isles," *Nature*, CXVII, 1926, 500.

" Kitchen Nuts " when broken to a small size, and are suitable for consumption in enclosed stoves. By way of contrast, household coals, those which are favoured for burning in open grates, still so prevalent in English homes, are coals which give a pleasant flame, and are described by the housewife as being " gassy." Then the coking property of coals is important. Good coking coals should also, of course, yield a large supply of gas, but if the coke is required for the iron industry, it is essential that it should be a good hard coke, and should not crush when loaded with a considerable weight of iron ore above it. The relative absence of intense folding in the British Isles has resulted in the comparatively small proportion of powdered coals of the types extensively used on the Continent of Europe for the manufacture of briquettes. It is indeed only in recent years that coal slack—dust—has been utilised at all in this country, and only a few collieries have briquetting plant for this purpose. The coal dust requires to be mixed with some material such as pitch which will act as a binding substance.

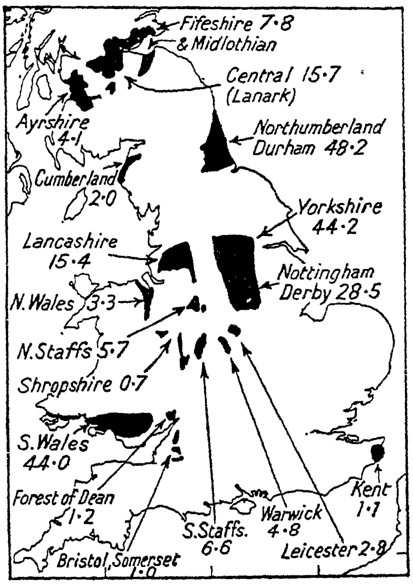


FIG. 142.—The Coalfields of Britain and their average output (in millions of tons, average 1927–31).

Notice that the outputs tend to be lower than those shown in the table for 1927–29, before the depression.

THE EXPLOITATION OF BRITISH COALFIELDS

The table given below (p. 284) shows in millions of long tons the output of the British coalfields. It is intended to illustrate the relative importance of the fields. The recently published Geological Survey 1 : 1,000,000 map of England and Wales now shows the position of the coalfields. The ordinary geological map merely shows the position of the exposed Coal Measures. Quite frequently, notably of course in the case of Ireland, the exposed Coal Measures are comparatively unproductive, and the most important parts of many British fields are where the Coal Measures themselves are hidden beneath a blanket of younger rocks, that is to say in the " hidden " part of the coalfield. The little map (Fig. 142) shows the relative importance of the fields, and also indicates roughly the extent of the production area. Most of

the British coalfields have been worked for a long time, some, for example, the Northumberland-Durham field, probably since about the twelfth century. The early mines were doubtless open quarries along the exposed edges of the seams. Then the seams were followed under the ground by adit mines, especially in those areas where it was possible to drain the shallow mines by a simple drain running out on to a neighbouring valley side. Mining by means of shafts followed, but for a long time the depth of the mines was severely limited by the impossibility of effectively draining the workings. The invention of Newcomen's Atmospheric Pumping Engine, which passed into general use in the Northumberland-Durham field about 1750, did much to remove this difficulty. Later the invention of the Davy Safety Lamp again rendered possible mining to greater depths, where previously the accumulation of fire-damp had been a great source of danger.

Minimum proved reserves	Field	Yearly average			
		1909–13	1922–4	1927–9	1931–5
1,537	Ayrshire [1]	4·1	4·5	4·3	3·9
3,049	Lanarkshire	17·4	19·4	16·6	13·6
2,500	Midlothian [2]	6·1	4·4	4·7	4·7
3,742	Fifeshire	8·8	8·5	8·1	7·8
5,510	Northumberland	14·0	13·7	13·7	13·0
870	Durham	40·4	36·6	36·1	29·3
1,528	Cumberland	2·2	2·2	2·2	1·5
26,000	Yorkshire	39·0	44·7	45·2	39·3
	Notts and Derby	31·5 [4]	30·2	28·5	26·6
4,367	North Staffordshire	13·9	6·3	5·9	5·9
1,415	South Staffordshire [3]		7·2	6·9	6·2
1,825	Leicestershire	—*	3·1	2·9	2·4
1,127	Warwickshire	—*	5·1	4·7	5·0
4,239	Lancashire	27·3	19·2	15·9	13·7
1,736	North Wales		3·2	3·4	2·8
26,000	South Wales	51·2	52·3	45·9	35·3
259	Forest of Dean	—*	1·3	1·3	1·2
4,198	Bristol and Somerset	2·7	1·3	1·0	0·9
2,000	East Kent	—*	0·4	0·9	1·9

* Details not available.

Two principal systems of mining have been followed in this country—the "pillar and stall" method, by which a pillar of unworked coal is left to support the roof and only the intervening part of the coal taken out—and the "longwall" method, by which the whole of the coal is removed, the roof being temporarily supported by pit props, and then allowed gradually to collapse as the coal is worked out. The first method sounds, and is actually, very wasteful, but it is sometimes economical because of the saving in timbering which is otherwise required. The importation of pit props into the country is a trade of very considerable importance.

[1] Ayrshire, Dumfries, and Argyll.
[2] Midlothian and E. Lothian.
[3] S. Staffs. and Worcestershire.
[4] Notts., Derby and Leicester.

For example, in the year 1931, pit props valued at £3,000,000 [1] were imported. During the nineteenth century, with the enormous development of British manufacturing industries, the expansion of the railways and their consequent consumption of coal, and also the facilities which they provided for removing it, the output of coal increased by leaps and bounds. Collieries became dotted all over the exposed Coal Measures, especially where the coal was near the surface. Workings were not always well planned. In many cases no record was kept of the coal which was removed, and no plans are available of the old workings. It is by no means an uncommon occurrence for a mine operating at the present day to break suddenly into an old working, with a consequent danger of flooding from the water that has accumulated in that old working. There are areas which cannot be more fully worked than they are at present because of this danger, and the impossibility of knowing the exact location of the old workings. Gradually, in practically all the fields, there has been a shift of the area of intensive working to those parts of the field where the seams lie at greater depths. This has necessitated greater capital expenditure, and for effective operation requires larger units. Thus in nearly all the fields of the British Isles there is a belt, usually the shallower older part of the field, where there are numerous small collieries together with abandoned workings. There is, on the other hand, a belt of newer and larger undertakings in the deeper parts of the exposed field or in the adjoining concealed region. Unfortunately, whilst the latter are frequently able to work at a profit it is not so with the older establishments. The problem is not so simple as might appear at first sight, because the shutting down of the smaller group would destroy the social organisation of villages, towns, lines of communication, and so on, which have been built up in connection therewith. Thus the older parts of the British fields really form a burden which has to be borne by the newer parts. Taking, thus, the Report of the Royal Commission on the Coal Industry, 1925, it is shown (p. 55) that practically all the heavy losses are confined to the smaller undertakings. Out of 114 undertakings altogether which were then making losses of more than 3*s*. a ton, 110 had a yearly output of less than 400,000 tons, and only four had a yearly output exceeding that amount. In district after district, the Report states, with only here and there an exception, the undertakings of the two lowest classes (output between 5,000 and 200,000, and between 200,000 and 400,000 tons) are worse than the district average in output per shift, in costs and profitability. Since the closing down of whole districts of the fields would cause such a terrible upset to the social organisation, it is clear why there has been insistence upon reorganisation on the basis of combination of interests. Where schemes for combined

[1] Representing nearly 2,000,000 loads or tons of 50 cubic feet.

working have not been put forward voluntarily they have been insisted upon. It has been urged that the British coal mines should adopt much more extensively coal-cutting machinery for the reduction of costs. The extensive faulting in most of the British fields, as well as the thinness of the seams, may make the use of coal-cutting machinery an uneconomic proposition, but the proportion mined in this way increased from 19 per cent. in 1924 to 42 per cent. in 1933 and in the Northumberland field actually exceeded 81 per cent. in the latter year.

THE PRINCIPAL FIELDS

Northumberland and Durham

The Coal Measures in Northumberland and Durham dip away from the Pennine ridge, and eventually pass under the waters of

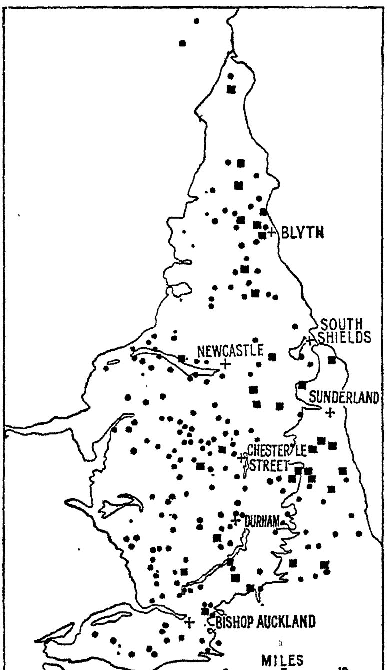


FIG. 143.—The Northumberland and Durham Coalfield, 1900.

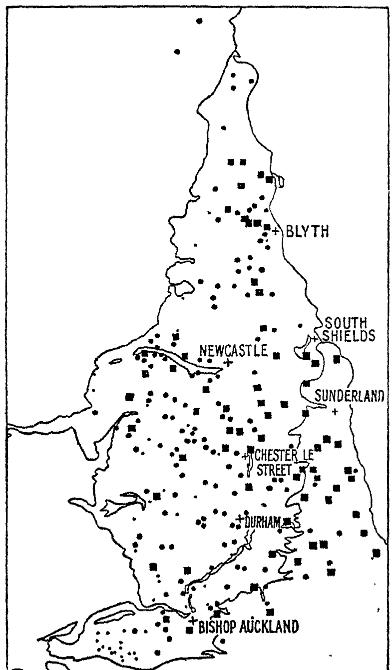


FIG. 144.—The Northumberland and Durham Coalfield, 1931.

The square dots represent collieries employing more than 1,000 men; the large round dots collieries employing between 100 and 1,000 men: the small dots collieries employing less than 100. The thin black line shows the limits of the *exposed* coalfield. It should be noted that in 1900 there were only 11 large collieries in the hidden coalfield; in 1931 the number had increased to 20.

the North Sea. In eastern Durham they are first covered by a thickness of Magnesian Limestone and other Permian sediments.

The older shallower workings of the field are thus situated on the flanks of the Pennines in the west, the larger and deeper modern collieries are nearly all to the east, and in many cases the coal is worked under a considerable thickness of overlying rock. Along the Northumberland coast the coal is followed under the sea, and four miles from the coast may be taken as the economic limit for the working of the coalfield. The two maps (Figs. 143, 144) show the position and size of the collieries in 1900 compared with those in

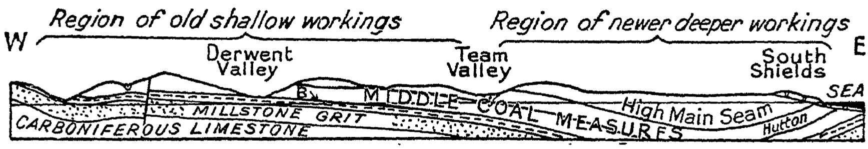


FIG. 145.—Section across the northern part of the Durham field (just south of the Tyne), showing the valleys which facilitated the early working of coal. B=Brockwell Seam. (*After Walcot Gibson.*)

1930, and demonstrate very clearly how the principal mines of the district have moved eastwards in the last thirty years. In 1900 it will be noticed that there were only eleven large collieries (*i.e.* employing more than 1,000 men) in the eastern, hidden part of the field; whereas by 1931, despite the depression in the coal trade, the number had increased to twenty. Some notes are given below on the development of coal mining in the Northumberland and Durham field, and indicate that coal working began at a very early date, and that it has always been associated with the movement of coal by water, either to other parts of this country, or to foreign countries. The field is, indeed, more conveniently situated for the export of

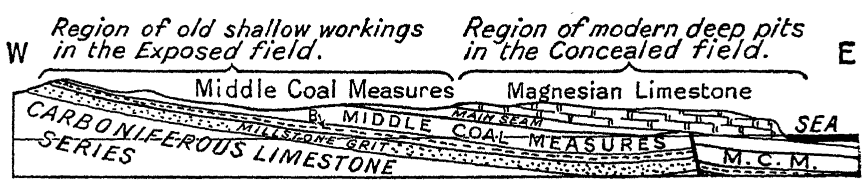


FIG. 146.—Section across the southern part of the Durham field, showing the thick mass of Magnesian Limestone covering the concealed coalfield. B=Brockwell Seam. (*After Walcot Gibson.*)

coal by sea than any other large *English* field. Hence it is not surprising that in normal years 35 per cent. of all the coal mined is exported, whilst a considerable proportion is taken to other parts of Britain by water, as for example to London. At all the coast ports, such as Blyth, as well as along the Tyne itself, are the erections known as staithes. The coal wagons are run straight on to these, and the coal is pitched into the holds of colliers waiting below.

Because of its dependence upon the export industry, the Northumberland–Durham coalfield has felt the effects of the post-1920 depression more than other fields in the country. In this respect its fortunes compare with those of South Wales. The two maps of this field add point to the general remarks given above. One notices, for example, the position of Bishop Auckland, a town of considerable size in the south-west of the field in an area which has for long been famous for the very excellent quality of its coking coal—perhaps the best of all coking coals for the iron-smelting industry. Yet Bishop Auckland is in a part of the field which must of necessity become worked out at an early date. It seems difficult to hope for the resuscitation of prosperity in such an area merely because of its actual geographical position on the field.

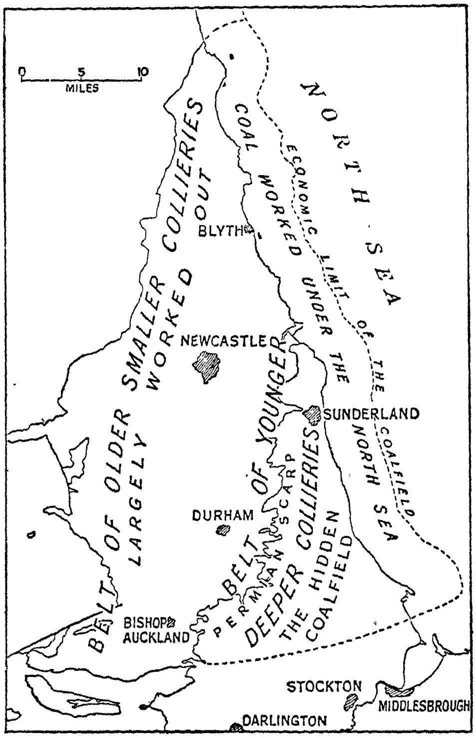


FIG. 147.—Map showing the limits of the Northumberland and Durham Coalfield.

The Lower Coal Measures, that is those exposed in the extreme western part of the field, contain a few thin but workable coals. The productive measures of the field begin with the Brockwell or Denton Low Main coal, and contain altogether about twenty-three workable coals. Many of the seams rest on beds of valuable fireclay, extensively used for the manufacture of firebricks. Amongst the best-known coals are the Hutton or Low Main, an extremely good gas and house coal in Durham, but north of the Tyne becoming a steam coal. Higher up is the famous High Main of south Northumberland, known also as the Wallsend coal, for household purposes; it was from six to seven feet thick, but is now very largely exhausted. Although the coals of Durham include some of the best coking and gas coals in the kingdom, others are much more suitable for household coal

There does not appear to be any difference in the chemical characters, the difference in the commercial value and use apparently depending upon physical and textural features. Steam coals become prevalent north of the Tyne. Two sections given here show the general disposition of the coal seams, and the way in which the Coal Measures are slightly folded under the cover of Magnesian Limestone. Numerous faults and igneous dykes cross the field, usually in an east and west direction. Two of the best-known faults are the Butter Knowle in South Durham with a throw of between 240 and 420 feet, whilst the famous Ninety Fathoms Fault shifts the Coal Measures in places no less than 1,000 feet. To the north and west of the Coal Measures, the Carboniferous Limestone series occurs and, as in Scotland, this contains in Northumberland some workable coals. Hence a few collieries are situated outside the area marked as Coal Measures on the geological map.

The gradual development of the Northumberland and Durham coalfield influenced the initiation and progress of manufacturing industries, not only there but throughout this country. Coal began to be used as a domestic fuel as early as the fourteenth century, and medieval London received its supplies by water as it does to a large extent to-day. It is not known whether the term " sea coal " refers to the fact that it was sea-borne from the northern coalfield, or whether it refers to the fact that fragments of coal were gathered there on the seashore, having been washed out of seams cropping out on the cliffs or along the coast itself. But, in any case, the scene of its early exploitation was the Northumberland and Durham coalfield, a field peculiarly suited for the primitive working of the mineral. Not only did the seams occur near the coast or near navigable water along the Tyne and the Wear, but the seams out-cropping at the surface could be worked by simple outcrop mining and then followed underground by gently sloping tunnels or adits. Even so, the early miner would soon have been prevented from following the seam underground owing to difficulties of drainage had it not been for the topography of the area. Over much of the tract, especially in the west of the field where the seams actually outcrop, the land is 200 or even 300 feet above sea level. The surface is broken up by considerable valleys, the lower course of the Tyne itself occupies a valley which, from its steeply sloping and quite lofty sides, is almost worthy to be described as a gorge. Thus the early miner had no particular difficulty in draining his adit mines to the lower ground of the valleys. Further, haulage presented comparatively few difficulties, and it is noteworthy that even as late as the beginning of the nineteenth century, just a little over a hundred years ago, all the collieries were readily accessible from navigable water. In the very early days the coal was taken down in baskets by trains of pack horses to the nearest point on the Tyne or on the Wear, which was navigable by the " keels " or coal barges. Lower down the river the coal was transferred from the keels to the 100-ton wooden coal vessels by which the coal was taken to London or elsewhere. More than 300 years ago there were 400 vessels of this type engaged in shipping coal from the Tyne alone. Much of the surface of Northumberland and Durham is covered with a heavy glacial drift. The paths and primitive roads were easily churned into a thick sticky mud by the trains of pack horses, and the condition of these tracks made their use by wheeled wagons practically impossible. The laying down of rough wooden tracks (corduroy roads) improved matters, and it was an obvious step to lay on these wooden rails

which guided the wheels of the wagons then used. The next stage was the use of cast-iron rails and, later, flanged wheels. In many cases, even over considerable distances, the loaded coal trucks descended by gravity and pulled up at the same time the empty trucks. In other cases the wagons were horse drawn. The railroad had evolved itself: it merely awaited the coming of the steam engine. The opening of the Stockton and Darlington Railway in 1825 solved what had previously been a very serious problem, and that was the transport of coal from the coalfield to the Tees. Previously it had actually been shipped from Tyneside to the Tees, and this illustrates the

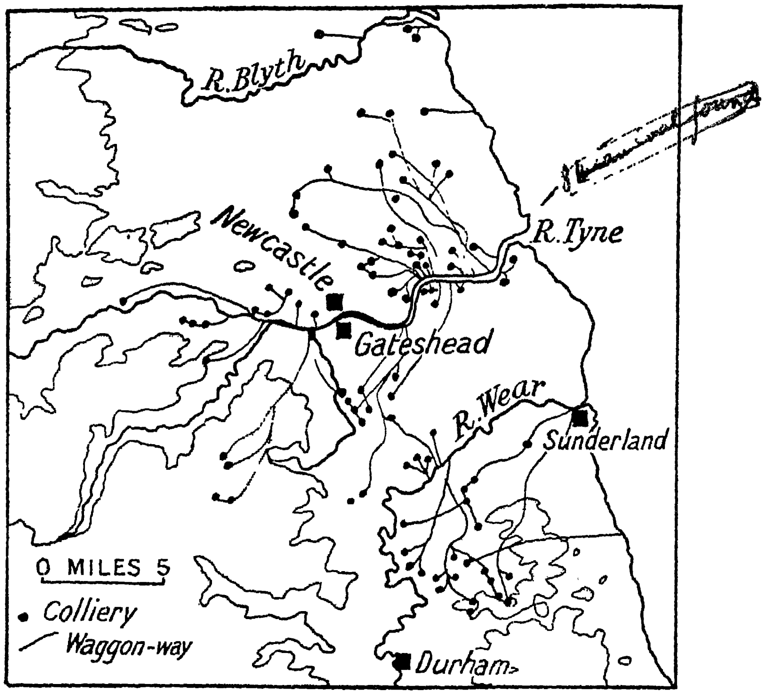


FIG. 148.—Old waggon ways and collieries, Northumberland and Durham field, 1830, showing the importance of access from navigable water. (*After Rodwell Jones.*) Land over 400 feet, stippled.

reason for the late development of the southern part of the Durham coalfield as well as pointing to the great difficulties of inland transport just over a hundred years ago. Within a few years the railway was extended to Middlesbrough and to Hartlepool. Reference has already been made to the steep-sided valley of the Tyne, and although there is a stretch of low-lying level land flanking the watercourse itself, advantage was taken at an early stage of the high banks by building out wooden projections from them in such a way that the coal wagons could be run out to the end—hence the origin of the staithes mentioned above.

Cumberland

Though only a small field, the Cumberland field resembles that of the other side of the Pennines by the way in which the Coal

Measures run under the sea, but this time westwards under the waters of the Irish Sea. The larger collieries are all situated on or near the coast, and the workings extend for a considerable distance—up to the limit of about four miles—under the sea, the limit being determined approximately by the cost of haulage from the working face to the shaft, which of necessity must remain on land. In addition to the exposed area and the area under the sea, there is a small extension of the coalfield under younger rocks towards the south, but a much larger extension to the north of Aspatria, where the Coal Measures are covered by Triassic rocks. It is probable that the Coal Measures extend right underneath the lowlands of the Solway marshes or the Carlisle Basin and reappear as the tiny Canonbie coalfield situated some distance to the north of Carlisle. The Coal Measures dip away from the uplift of the Lake District, that is towards the west and north-west. There are numerous faults with throws of from 300 to 600 feet running from north-west to south-east across the coalfield, and the northern edge of the worked field in Cumberland is determined by a complicated belt of fracture. It is not known to what depth the Coal Measures are faulted down to the north of that line, and whether they will ever be worked under the Solway lowlands or not. In the Whitehaven area the Main Band (five to six feet thick) is the most valuable seam.

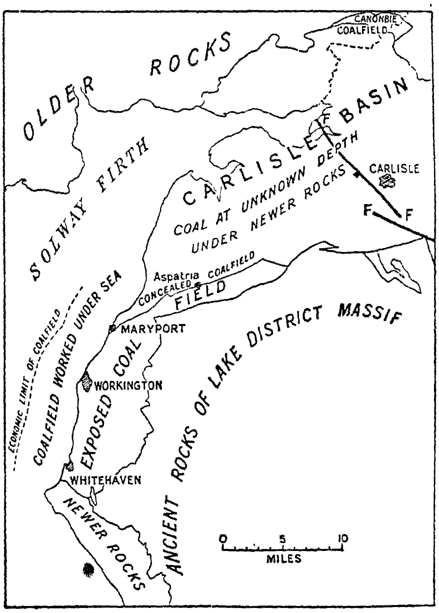


FIG. 149.—Map showing the limits of the Cumberland Coalfield.

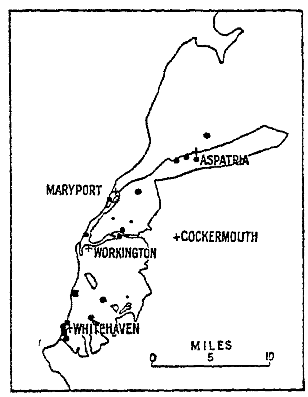


FIG. 150.—Collieries of the Cumberland Coalfield, 1931.
(For explanation, see Figs. 143, 144.)

Coal Measures towards the south, where they pass underneath a cover of Triassic rocks. Here is to be found probably the maximum thickness reached by Coal Measure rocks in the British Isles, but unfortunately the southward dip of the rocks increases as they pass under the Triassic cover, and thus the hidden coalfield has economically a limited extent towards the south. It is probable that Coal Measures underlie the whole of the Triassic Plain of Cheshire,

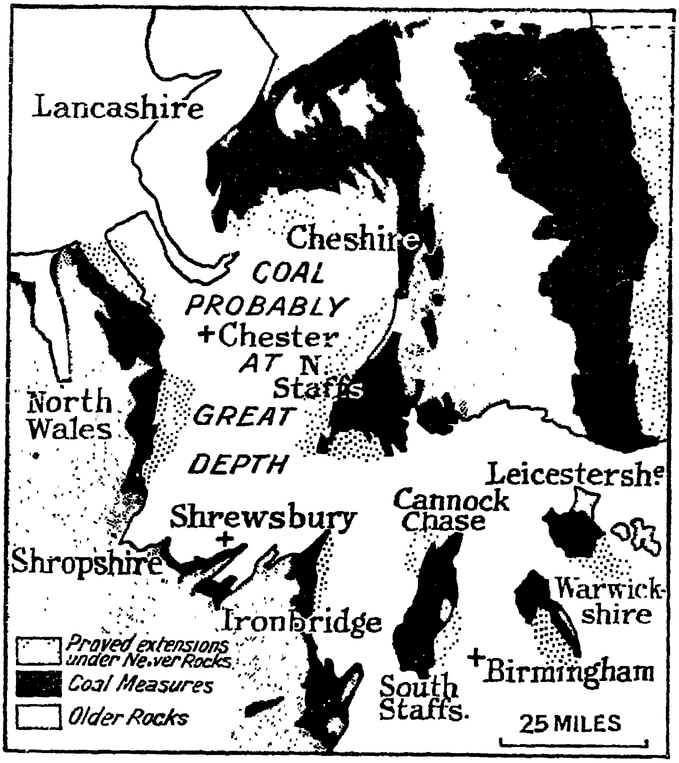


FIG. 152.—The exposed and hidden coalfields of the Midlands, and their relationship to one another. See note under Fig. 151.

and are connected directly with the fields of North Wales and North Staffordshire. Whether these deep-seated Coal Measures under the Triassic Plain of Cheshire will ever be worked is not yet known. The curiously irregular southern edge of the exposed measures in south Lancashire is due to the numerous and large faults which cut across the Coal Measures in a direction roughly from north-west to south-east. Farther east the faults take on a north and south trend, and that of the Irwell Valley has a throw estimated at 3,000 feet in places and of 1,200 feet where it passes through Manchester.

Farther east still the Bradford fault has a vertical displacement of something like 1,800 feet, so that the dislocation caused by these faults in the southern part of the coalfield is very serious indeed. As in so many of our coalfields, the greater part of the faulting took place before the deposition of the succeeding rocks of the Permian Period, and represents fracturing which was occasioned by the Carbo-Permian earth movements (see p. 14). Amongst the famous and important seams of this field, which have been extensively worked, are the Wigan 9-feet, the Arley, and Yard coals. In the Wigan district the well-known Wigan cannel coal (a corruption of "candle" coal because splinters when lit by a match will burn with a flame like à candle) overlies the King coal. But this curious coal, which occurs practically nowhere else in Britain, is now practically exhausted. Its character is believed to be due to a difference in the mother substance of the coal, since it has been found to consist mainly of the spores or the seed-bearing organs of the ancient tree ferns which have gone to make up ordinary coals.

(3) *The Manchester Coalfield.*—This field is farther east, and the Coal Measures extend southwards into east Cheshire. Not unexpectedly the Coal Measures in this area can be correlated with those of north Staffordshire to the south, while it is possible to recognise some of the seams of the Yorkshire coalfield on the far side of the Pennines, and there is little doubt that the Coal Measures were originally deposited continuously across the area now occupied by the Pennine Uplift.

In the great triangular centre of the Lancashire coalfield, which is occupied by the Millstone Grit and the Lower Coal Measures, the country is mainly hilly, whereas the land occupied by the higher Coal Measures is for the most part comparatively low lying. Thus the few coals which have been worked in the Lower Coal Measures are often called "Mountain-Mine" coals because of their position.

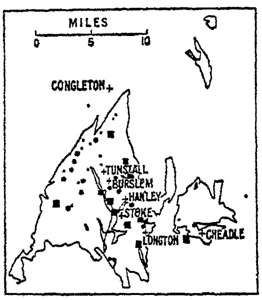


FIG. 153.—The North Staffordshire or Potteries Coalfield, 1931.

The North Staffordshire or Potteries Coalfield

At its southern end, the western margin of the Pennine Uplift is marked by the existence of a number of small intensive folds. In the western, and by far the deepest fold, the Coal Measure sequence is preserved intact. In the Cheadle basin very much less remains, whilst further east only the lowest and least productive parts of the Coal Measures have escaped denudation in the shallow troughs lying amongst the older rocks. Thus the North Stafford-

shire Coalfield is characterised by extensive folding and faulting of the Coal Measures. The most important coals occur in the Middle Coal Measures. There are some coals in the Lower Coal Measures, but in the Upper Coal Measures, apart from the lower group (Blackband Group), the rocks become reddish and barren, and are held by some to indicate the oncoming of desert conditions towards the close of the Coal Measure period in the British Isles. It is estimated that in 4,000 feet of strata, the coalfield contains an aggregate of 140 feet of coal in thirty seams of over two feet in thickness, vertically distributed in such a manner as to permit most of them being worked by one pit at any one place. The coalfield is especially important because numerous seams of good quality are well adapted to the requirements of the industries which have become situated on the field. In the west there are some good gas and coking coals. To the geologist, the North Staffordshire coalfield is one of the most interesting in the country because of the very complete succession of Coal Measure rocks which it exhibits, and because too of the interesting fossils, particularly those associated with marine bands which occur at several horizons in the sequence.

The North Wales Coalfield

This coalfield may be taken next, because it represents the western exposed portion of the huge basin which probably underlies Cheshire. The Carboniferous rocks rest unconformably on highly folded ancient sediments of the Ordovician and Silurian periods, indicating that the Welsh massif formed an island at the time of the deposition of the Coal Measure rocks. So much of the Coal Measures is covered by drift that the structure is only known from the results of mining, and a huge fracture running roughly from east to west divides the field approximately into a northern or Flintshire portion, and southern or Denbighshire portion. Some of the most important coals are steam coals, but in addition there are house and gas coals. Beneath the Triassic cover to the east, the coalfield is worked in the southern part of the Wirral peninsula, and borings show that the whole field has a very complicated structure.

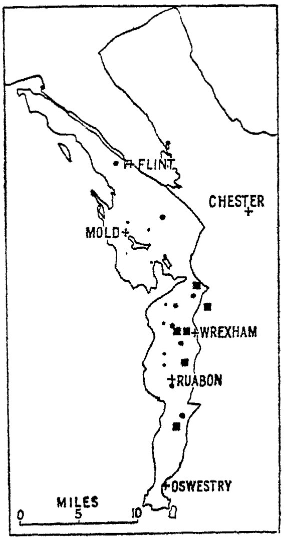


FIG. 154.—The North Wales Coalfield, 1931.

The Shrewsbury or Central Shropshire Coalfield

This little field with its three seams, having a total thickness of six feet, may be mentioned here because it seems to represent the southernmost extension of the Cheshire basin, and the Coal Measures are resting on the ancient rocks of the Welsh massif. Old rocks occupy the whole area southward.

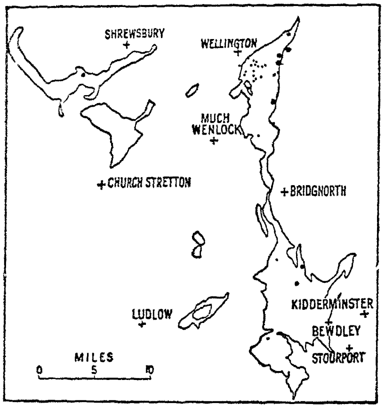


Fig. 155.—The Shropshire Coalfields, 1931. Coalbrookdale and Ironbridge (p. 303) lie north-east of Much Wenlock.

Yorkshire, Nottinghamshire, and Derbyshire Coalfield

Whilst it is a common practice to regard as three fields those of West Yorkshire, South Yorkshire, and Nottinghamshire and Derbyshire, in reality the three form one huge coalfield with a common geological structure and containing for the most part the same types of coal. The whole area, it is true, is divisible into a western visible coalfield, and an eastern concealed coalfield where the Coal Measures are covered by Permian, Trias, and later rocks. There is a certain geographical distinction between the three areas, the West Riding coalfield being associated particularly with the woollen manufacturing area of the West Riding, with its centres at Leeds and Bradford; the South Yorkshire being associated particularly with the iron and steel industry of Sheffield and Doncaster; whilst the Derby and Nottinghamshire coalfield—the southern portion—is associated with such rather more isolated industrial centres as Nottingham and Mansfield. The limits of the concealed coalfield, especially to the north-east, are as yet unknown; but the total known area of the field exceeds 2,300 square miles or more than twice the size of the South Wales coalfield, and the field as a whole undoubtedly has the greatest reserves of any British field, exceeding in this respect even the rich South Wales field. The Coal Measures of the fields on the eastern side of the Pennines are less disturbed than those on the western side (Lancashire and North Staffordshire), and this is true of the great coalfield of Yorkshire, Nottingham, and Derby. The Coal Measure rocks dip gently away from the Millstone Grit areas of the Pennine Uplift. Consequently there is a long band of Lower Coal Measures exposed in the extreme western part of the field. As usual in the Lower Coal Measures, the coals are on the whole few and poor, but in Yorkshire the Ganister Coal is extensively

mined between Sheffield and Huddersfield, as well as around Halifax, though largely in connection with the underlying ganister and associated fireclays that afford high-class refractory materials of world-wide reputation. Then the Kilburn Coal of the Lower Coal Measures is famous as an almost ash-free house coal. This appears

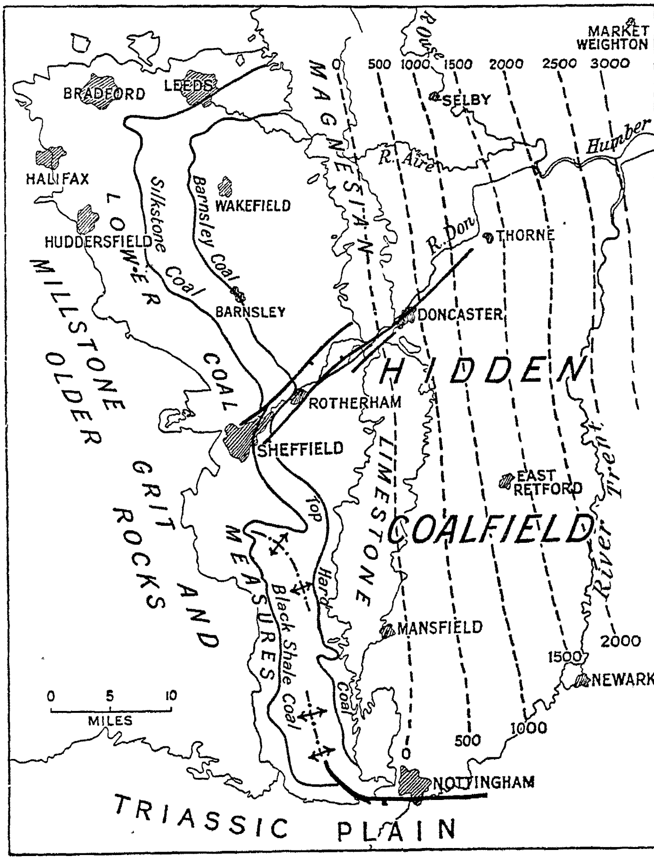


FIG. 156.—Map showing the extent and major features of the Yorkshire, Nottinghamshire, and Derbyshire Coalfield.

There is a southern extension of the hidden field under the Triassic Plains. The broken lines to the east indicate the depth in feet below sea-level at which Coal Measures are reached.

particularly in the southern part of the field and is scarcely recognisable in Yorkshire, where, however, around Bradford, Leeds, and Wakefield the Better Bed Coal is one of great purity, and pre-eminently suitable for iron smelting. Around Leeds the Beeston coal, formed by the union of two coals, is occasionally as much as eight feet thick, and is one of the most valuable seams in West Yorkshire. But on the whole it is the Middle Coal Measures

which contain the most seams, and in which the formation of coal reaches its maximum development as regards thickness, quality, and the persistence of the individual seams. The famous Silkstone seam, the chief gas and coking coal, also well known as a house coal, is taken as the base of the Middle Coal Measures; whilst an almost equally famous seam, the Top Hard Coal of Nottinghamshire (known

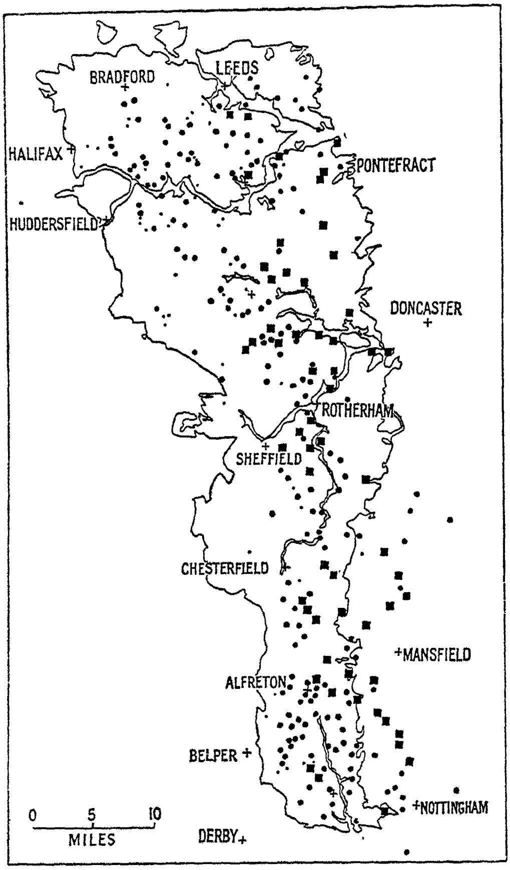


FIG. 157.—The Yorkshire, Nottinghamshire, and Derbyshire Field, 1900.

Square dots = collieries employing more than 1,000 men. Large round dots = collieries employing 100 to 1,000. Small dots = collieries employing less than 100. Notice that there are only 11 large collieries in the hidden field.

as the Barnsley coal in the Barnsley area) can be regarded as dividing the Middle Coal Measures into two parts. It is only in the extreme north of the field that the Barnsley coal deteriorates and passes into the Warren House coal. High dips amongst the coal seams are the exception in this great field, and are limited to a few restricted areas. Consequently mining operations are carried on with a greater facility

than in any other British coalfield. As shown in the diagram there are local anticlinal folds,[1] especially in the south, but on the whole faulting on an extensive scale is much less noticeable in this field than in most British fields. One of the most important groups of faults are those known as the Don faults, and it is seen that a trough is formed between the two main faults, and along this trough line the Don itself runs. As one passes eastwards into the concealed coalfield,

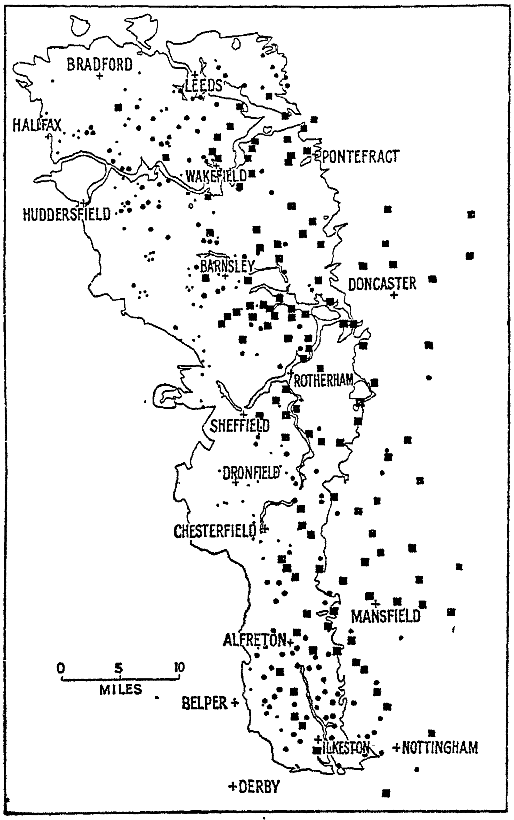


FIG. 158.—The Yorkshire, Nottinghamshire, and Derbyshire Field, 1931.

There are no less than 35 large collieries in the hidden field. Notice especially the development round Doncaster and in the D[illegible] east of Mansfield.

the cover of Permian and Triassic rocks gradually increases in thickness, so that along the line of the River Trent there is an overlying thickness of more than 2,000 feet of strata to be penetrated before the Coal Measures are reached. A boring at Market Weighton passed through 3,100 feet of the covering rocks without reaching the Coal Measures. Underlying this cover of Permian and Trias, it is found that the Coal Measures lie in a gently folded basin, so that

[1] Notably the Brimington anticline near Chesterfield and the Erewash anticline between Alfreton and Ilkeston.

as one goes eastwards, the lower part of the Middle Coal Measures, Lower Coal Measures, and finally the Millstone Grit are the rocks reached beneath the cover of later strata.[1] The Upper Coal Measures occupy a very restricted area in the whole great coalfield, but this is not of great importance since the most important seams are in the Middle Coal Measures. But even if one takes the area over which the workable Barnsley or Top Hard coal is known in the concealed portions of the coalfield, it is found that this seam alone exists over 600 square miles, and contains at least 2,000,000,000 tons of high-class coal within a depth of 3,000 feet from the surface. The high commercial value attached to this particular seam depends particularly on the presence of a hard semi-anthracitic coal, known as "hards" or "hard coal," furnishing a really first-class steam coal; whilst other parts of the seam yield a house, manufacturing and, to a less degree,

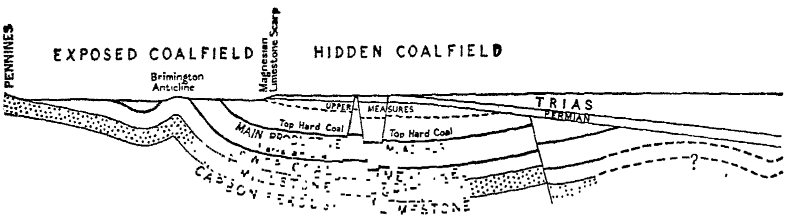


Fig. 159.—Diagrammatic section from west to east across the Derby-Nottinghamshire Coalfield.

gas coal. In Nottinghamshire this seam varies from a little under three feet to a little over six feet in thickness, with an average for the proved area of four feet of good coal; whilst in Yorkshire an average thickness of six feet can be reckoned. If one examines the two maps, Figs. 157 and 158, showing the distribution of the collieries in the whole coalfield in the years 1900 and 1931 respectively, it will be noticed that there is, just as in Northumberland and Durham, a belt of small workings occupying the western exposed parts of the coalfield. Here, as in the more northern field, workings are shallow and the seams largely worked out, working faces are too frequently at a great distance from the shafts, and the undertakings must, on the whole, be described as uneconomic. But farther to the east, the concealed coalfield was not touched at all until 1859, and it is particularly in the neighbourhood of Doncaster that one has a large group of collieries up to date in their construction and equipment, and forming large units capable of working on a profitable basis. Once again it is the larger, newer units in the eastern part of the field which must carry the older uneconomic units of the other

[1] Later investigations suggest the presence of an anticline and a possible further eastern extension of the field as far as Lincoln Edge.

half of the field as a permanent burden. Even in thirty years the change is remarkable, for the map shows that in 1900 there were only eleven collieries in the concealed part of the coalfield employing more than 1,000 men each; in 1931, despite the post-War depression of the coal trade, the number had increased to thirty-five.

The Midland Coalfields

The Midland coalfields of Leicestershire, Warwickshire, South Staffordshire, and the Forest of Wyre with Coalbrookdale have certain features in common. The Coal Measures were deposited in bays or hollows in the old land mass which we have called St. George's Land which then stretched across south-midland England. Frequently there are no older Carboniferous rocks than the Middle Coal Measures which, therefore, rest directly on the ancient floor. This ancient floor usually slopes northwards and the Coal Measures nearly always thicken from south to north. In the northern parts of the fields there is often a considerable number of coal seams which, when traced southwards, are found to converge to form one or more very thick seams. After their deposition the structure of the fields was complicated by the formation of a very extensive series of north and south faults, and folds which also have axes running from north to south. The combined faulting and folding has resulted in the further separation of the fields into separate portions. In addition, there are frequently important east-west faults, so that the geological structure of the small Midland coalfields is often very complicated.

(*a*) *Leicestershire.*—This coalfield lies between the old Cambrian rocks of the Warwickshire coalfield on the west and the Pre-Cambrian rocks of Charnwood Forest, north of Leicester, on the east. The coalfield includes an area of about 60 square miles in the county of Leicester together with about 15 square miles in South Derbyshire. Over this tract the Coal Measures are exposed at the surface over an area of 24 square miles with Ashby-de-la-Zouch as a centre, the most important part of the concealed coalfield lying to the south-east. The Lower Coal Measures are thin and unimportant and only one small seam has been worked. Most of the seams lie, therefore, in the Middle Coal Measures and occur in the eastern and western areas separated by an anticlinal fold of Lower Coal Measures. The Royster coal on the east and the Kilburn coal on the west are usually the lowest workable seams and are regarded as the base of the productive series. The Main Coal is the standard coal of the district and consists of two seams in the north which unite in the south to form one thick seam of 14–16 feet. The Main Coal is a steam, house, and manufacturing coal, the Royster for the most part a manufacturing coal. The Leicester-

shire coalfield is remarkable in one respect, that it has not given rise to an extensive industrial area and the coal mining centres remain small towns or often mere villages, as for example Coalville and Ashby-de-la-Zouch.

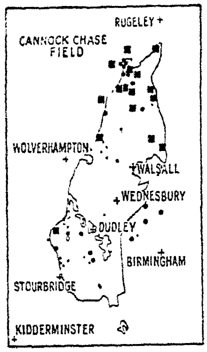


FIG. 160.—The South Staffordshire Field (including Cannock Chase, 1931). The virtual extinction of mining in the old "Black Country" should be noted.

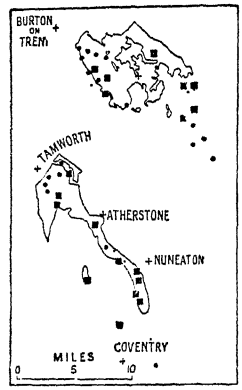


FIG. 161.—The Leicestershire and East Warwickshire Fields, 1931. The unnamed cross marks Ashby-de-la-Zouch.

(*b*) *The Warwickshire Coalfield.*—The total area of this field is about 150 square miles and a large part of the field is occupied by the highest and barren Coal Measures to which the productive Measures form a narrow fringe on the east and north. Again the Coal Measure rocks were deposited in an old bay. Carboniferous Limestone and Millstone Grit are nearly always absent, and the Coal Measures rest directly on the ancient Cambrian rocks. Even the Lower Coal Measures themselves seem to be absent. The Middle Coal Measures, the productive series, are about a thousand feet thick in the Tamworth area in the north, but thin southwards. As one goes southwards the coal seams tend to unite, so that in the Newdigate collieries the separate seams have coalesced to give a thickness of over 23 feet to the thick coal or the Hacksbury seams. Below this is a seven-foot coal which is known to occur all over the field. Though in the northern part of the field coal seams to a total thickness of 35 feet occur, the seven-foot coal is the thickest and the most important. The coals are bituminous coals for domestic and manufacturing purposes. With the exception of the Arley and Coventry collieries the coal pits are situated more to the northern part of the field or along the eastern outcrop, but for an area of something like 60 square miles the coals remain untouched. In this southern part of the field there is a difficulty with water in the overlying beds, but the chief obstacle in successful mining is the excessive thickness of the Thick Coal. This deserves to be stressed because it might be thought that a very thick coal would be an

extremely valuable one, but the expense of timbering (or, alternately of working the coal in horizontal sections) is enormously increased.

(c) *The South Staffordshire Coalfield.*—The total area of this field is about 149 square miles. Again, in the southern part, the Coal Measures rest on an irregular floor usually of Silurian rocks, and the main structure of the field is an anticline, so that these Silurian rocks are actually seen as inliers in the centre of the field and form the famous Wren's Nest near Dudley, for long important because of the supply of limestone which was afforded for fluxing purposes in the days when this coalfield, under the title of the Black Country, was the centre of the iron-smelting industry of Britain. Once again the Lower Coal Measures seem to be absent, at any rate in the southern part of the field; and even the Middle Coal Measures are only 250 feet thick in the south although they thicken to nearly 2,000 feet in the northern part of the field. The thinner seams in the north coalesce to form the famous Thick coal in the south, where it occasionally reaches 36 feet in thickness and has an aggregate thickness of over 30 feet over a considerable area. The coals of the South Staffordshire field are bituminous in character and suitable for house, manufacturing, and local uses. The seams of Cannock Chase have a specially high reputation as house coal. As in the two previous fields the boundary faults to the east and west are important, and it is not known to what depth the Coal Measures may be faulted down, but probably below workable depth.

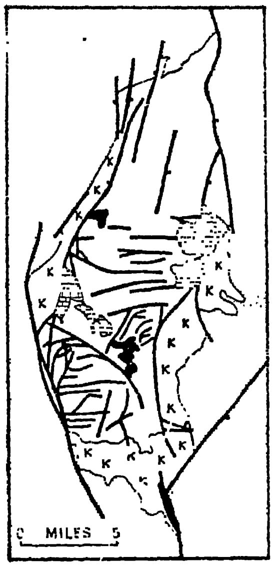


FIG. 162.—Sketch map illustrating the complicated faulting in the South Staffordshire Field.

Silurian limestone is shown outcropping in the heart of the field: black areas are [illegible]. K [illegible] is [illegible]; dotted, [illegible].

(d) *The Forest of Wyre Coalfield.*—This occupies a hollow in the ancient rocks, and although having an area of 50 square miles it has very small reserves of coal. The same is true of the *Coalbrookdale* field, which is of the greatest interest because of the fame of the district in the history of the iron trade. Here coke-smelted iron was first produced, and at Ironbridge the first bridge constructed of iron was erected and is still standing (see Figs. 155 and 179).

The South Wales Coalfield

This is different from all other British fields, with the exception of its small neighbour the Forest of Dean, in that it is a true basin of wholly exposed Coal Measures. Indeed, the South Wales field may be likened roughly to a pie dish elongated from east to west and with a rim which is formed of Millstone Grit and Carboniferous Limestone, usually flanked by still older rocks. In the centre of the pie dish there is a three-fold sequence: a Lower Series of coal-bearing rocks, then a thick sandstone usually without coal (Pennant Grits) and then an Upper Series of Coal Measures. One would expect the Coal Measures to be at the greatest depth in the centre of the pie dish. That is not the case because of an important upfold, also with an east and west direction, which brings the Lower Coal Series comparatively near the surface even in the centre of the field, and which results in the distribution of the Upper Series usually in two distinct basins in the north and south, respectively, of the main basin. The whole field has a length from east to west of about

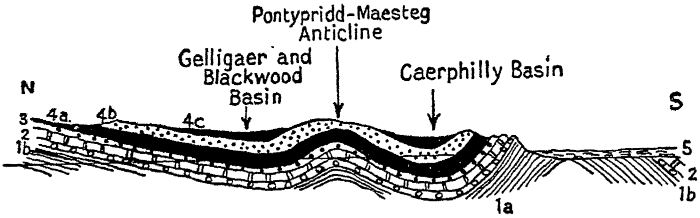


FIG. 163.—Diagrammatic section through the east of the South Wales Coal basin.

1a, Silurian and lower Old Red Sandstone; 1b, upper Old Red Sandstone (conglomerates, etc.); 2, Carboniferous Limestone; 3, Millstone Grit; 4a, lower Coal Series; 4b, Pennant Grit; 4c, upper Coal Series; 5, Mesozoic and later rocks.

90 miles. Its greatest width, 16–17 miles, is in Glamorganshire. An average width of about 15 miles is maintained as far as Swansea Bay. Westwards the coalfield narrows and in the western part of Pembrokeshire it is scarcely three miles across. If one includes the portions covered by the sea in Swansea Bay and Carmarthen Bay the area of the coalfield is over 1,000 square miles, and it has very extensive reserves. The topography of the greater part of the coalfield is particularly characteristic in that deep transverse valleys have been, and to a great extent still are, the main factor determining the location of collieries, villages, and towns. In the early days levels were opened up along these steep-sided valleys, and the first mines were thus with natural drainage to the valleys. Even now shafts are usually sunk in the valleys to avoid passing through an unnecessary thickness of the Pennant Grit or other barren rock. Between the deep valleys are large tracts of moorland

at a considerable elevation above sea level; and from the surface of these wide open moorlands it is often impossible to see a colliery and to realise that one is in the heart of a coalfield. Turning to details in the geological structure, apart from the central anticline which lies in the middle of the main synclinal basin, there are other similar anticlines which thus bring the lower coals within mineable reach. Then the whole of the main basin is crossed by a pronounced and remarkably regular series of faults trending in general from north-north-west to south-south-east. Some of these form trough faults with "troughs" of Coal Measures let down between them, but on the whole they throw westwards, so that it is in the neighbourhood of Swansea that the lower coals are found at their greatest depth. In fact they are depressed below 4,000 feet and cannot under present conditions be mined. Then there is another and very important series of faults, the faults trending west-south-west and commencing particularly at the Vale of Neath and then found with great intensity further westwards. Important rivers, notably the Neath, find their way along the fault lines towards the sea. Away in the north-west of the coalfield and in Pembrokeshire folding and faulting have been very intense; frequently the beds are overfolded and there are great thrust faults, and the whole structure is such as to render mining difficult. The development of the South Wales coalfield has been influenced to a very large extent by the high quality and the variety of the coal. Whilst bituminous coals are present in quantity there are the well-known steam coals and anthracites, both of which are characterised by a high percentage of carbon and a low percentage of volatile matter. In many South Wales coals, in addition, the ash is very small in amount. This is particularly so in the anthracite. Whilst bituminous coals commonly have an ash content of five to ten per cent., that of the steam coal of South Wales is frequently under four per cent., and in the case of the anthracite it is only about one per cent. Anthracite is found in the detached portion of the coalfield, in Pembrokeshire, and also in the north-western part of the main field from the Gwendraeth Valley approximately as far as the head of the Vale of Neath. The seams are in the Lower Coal Series. Eastwards and southwards towards Pontypool and towards Bridgend the anthracite seams change in character, each seam passing first into a steam coal and then into a bituminous coal. Thus towards the south crop of the coalfield from Swansea to near Newport the seams in the lower part of the Coal Measures are bituminous, whilst between this area and the anthracite district they are mainly steam coals of various grades. It is particularly around Aberdare and in the Rhondda Valley that the most famous of the steam coals have been mined. The coals of the Upper Series are generally bituminous coals. Broadly speaking, about 50 per cent. of the coal available

in South Wales is steam coal, about 30 per cent. bituminous, and about 20 per cent. anthracite. Coal was undoubtedly worked in the South Wales field as early as the thirteenth century, whilst towards the end of the sixteenth century it was being used for the smelting of copper at Neath (see p. 418). For some considerable time most of the working in the northern part of the field was done by what is called "patching"—digging the nearly horizontal seams in open workings. This was succeeded by workings in bell pits, the shallow pit being dug near the outcrop of the seam, and workings being made outward from it in all directions until it was considered unsafe to proceed further. As the collieries and workings became deeper, mining became unpopular; so that in the seventeenth century it was not uncommon for criminals to be pardoned by the

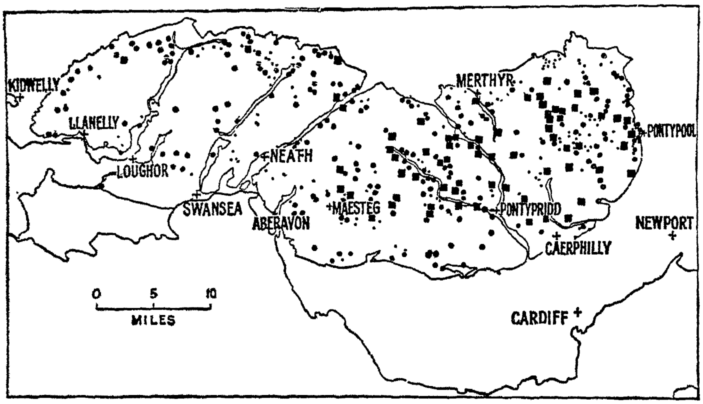
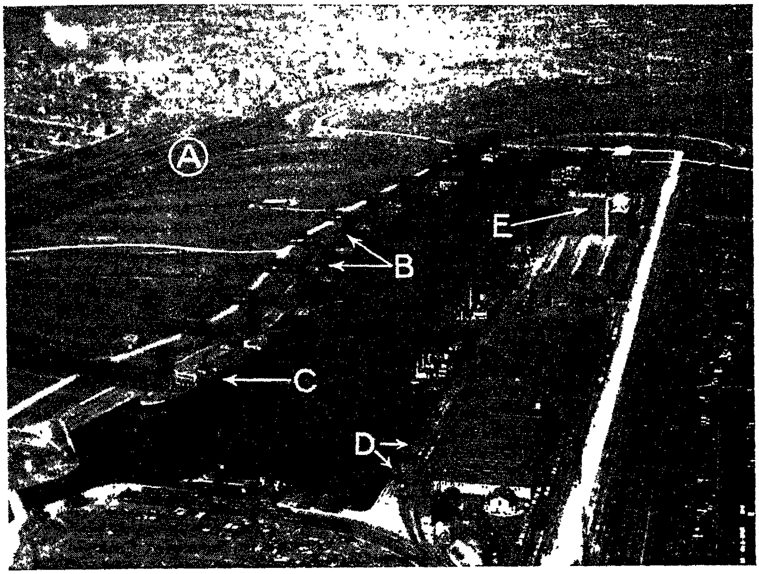


FIG. 164.—The South Wales Field (excluding the western extension), 1931. Notice the effect of the Pontypridd-Maesteg Anticline in the disposition of the collieries.

king on condition that they would work for five years in the mines. In the latter part of the eighteenth century coal began to be used generally in the iron industry and there followed the great expansion in the export trade in coal. A detailed map of South Wales will show the way in which the valleys in the south-east of the field join and lead to two main centres—Newport and Cardiff. The export trade of Newport developed particularly after the opening of the Monmouthshire Canal, and the quantity exported rose from about 10,000 tons in 1798 to no less than 148,000 tons twelve years later in 1809. Some years afterwards Cardiff developed as an exporting port, but not before Swansea had attained great importance. Tramways and canals brought the coal to the ports, and the construction of the Taff Valley railway (completed in 1841) to Merthyr and Aberdare helped greatly in the development of the export trade, whilst the opening of the Bute Docks at Cardiff

in 1839 was a very important factor. Of the coal raised in South Wales at the present time, some is used locally, and a considerable quantity goes to the manufacture of coke for metallurgical works. In 1913, however, no less than 70 per cent. of the total output was exported either abroad or to other parts of Britain by water. The prosperity of the South Wales coal industry is thus dependent to an enormous extent on the export trade. The field has suffered correspondingly from the diminution in that trade. Cardiff,



[*Photo : Courtesy of the Great Western Railway.*

FIG. 165.—Aerial view of Barry Docks, showing facilities for coal export.

A = marshalling sidings; B = automatic coal chutes; C = a collier being loaded; D = cranes for handling the limited incoming cargoes; E = flour mill for handling imported grain.

including Penarth and Barry, is easily the most important port and ships some 60 per cent. or more of the coal; followed by Newport with about 17 per cent., and then by Swansea (about 11 per cent.) and Port Talbot (about 8 per cent.). The two remaining ports, Llanelly and Milford, handle comparatively very little.

The Forest of Dean Coalfield

The small Forest of Dean coalfield is composed of entirely exposed Coal Measures surrounded by a rim of Carboniferous Limestone and separated from the South Wales field by a broad expanse of Old Red Sandstone. The Coal Measures occupy an area of about 44 square miles and the total thickness of the Measures

is about 1,400 feet. There are several coals which are extensively worked, the three main centres being the towns of Coleford, Cinderford, and Lydney.

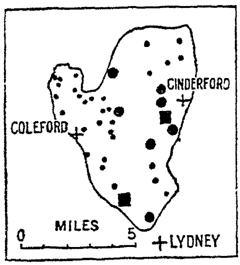


Fig. 166.—The Forest of Dean Coalfield, 1931.

Note: This is twice the scale of the other coalfield figures.

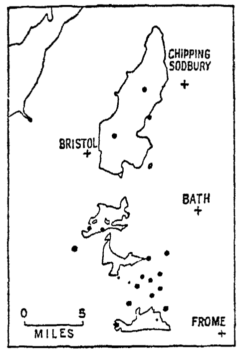


Fig. 167.—The Bristol and Somerset Fields, 1931 (see also Fig. 35).

Somerset and Gloucestershire Coalfields

In Somerset and Gloucester there are six detached areas of Coal Measures completely different from the South Wales field in that each is surrounded by strata newer than the Coal Measures, except where a rim of Carboniferous Limestone exists (for details, see Chapter III and Fig. 35), and most of the coal mining is carried on chiefly under the newer formations. Four-fifths of the coalfield can actually be described as concealed. The exposed rocks occupy about 50 square miles, the concealed Measures about another 190. The coal seams are worked in three main areas. In the south there is a total thickness of about 23 feet of coal, slightly farther north in the Radstock area the seams increase in number and thickness, whilst the northern or Kingswood field is poorer. Geologically the fields are interesting in that some of the coals are believed to be of much younger date in the Coal Measure sequence than those in other parts of England.

The East Kent Coalfield

Long before the end of last century geologists confidently predicted that a concealed coalfield would be found underneath south-eastern England. Prestwich and Godwin Austen in particular in the 'seventies of last century were certain of the matter. The field was first discovered when excavations for the proposed Channel tunnel near Shakespeare Cliffs, Dover, were temporarily suspended and engineers bored downwards. This occurred in 1890. During the succeeding 25 years a number of boreholes were put down

and the limits of the coalfield broadly determined. It forms a basin extending as far north as Sandwich, a little north of Canterbury, and westwards is bounded by a sharp fold, so that there is a rough north-south line limiting the field a short distance west of the longitude of Folkestone. It is now estimated to have an area of 206 square miles, of which 56 square miles, however, lie at a workable distance from the shore but below the sea. Financial mis-

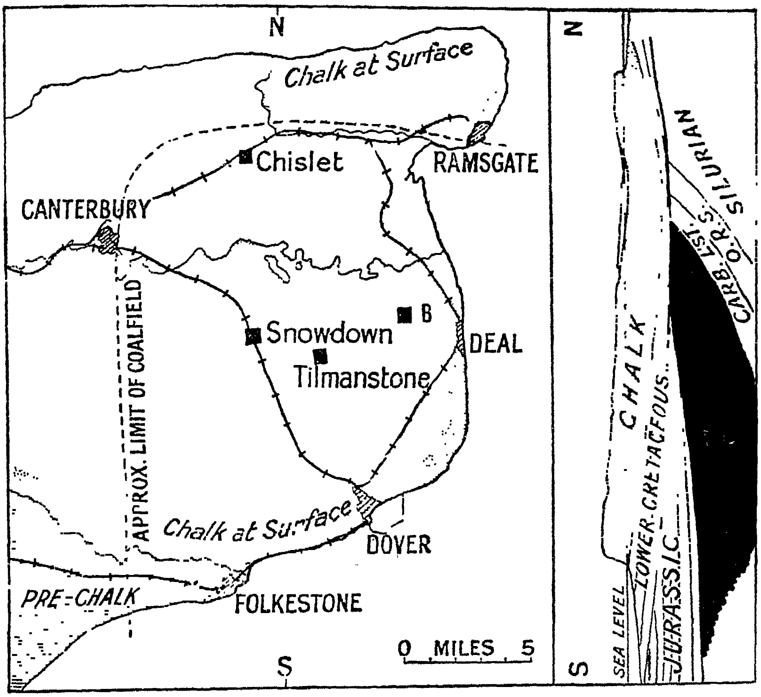


FIG. 168.—The East Kent Coalfield and a section through it (with the Coal Measures in black).

The area with a stippled margin is where chalk outcrops at the surface. The four collieries are those working in [illegible]. B = Betteshanger.

management—the floating of a large number of companies of doubtful standing—was responsible for the field getting a bad reputation in its early days. The coal is undoubtedly there, and the three active coal mines are now Snowdown, Tilmanstone, and Betteshanger. The field is conveniently situated for the port of Dover, and an overhead ropeway now takes coal in limited quantities to that port.

The Scottish Coalfields

The Scottish coalfields have been left for consideration until last because they differ very much in character from those of the

rest of Britain in that the coal seams occur, not only in rocks of Coal Measure age, but also in rocks which are contemporaneous with the great mass of the Carboniferous Limestone developed in England. Most of the Carboniferous Limestone coals are in the middle subdivision of that series, known as the Limestone Coal Group or sometimes, though wrongly, as the Lower Coal Measures. Geologically, of course, the whole Midland Valley of Scotland is a broad syncline of sedimentary rocks let down between the older rocks of the Highlands on the north and of the Southern Uplands on the south.

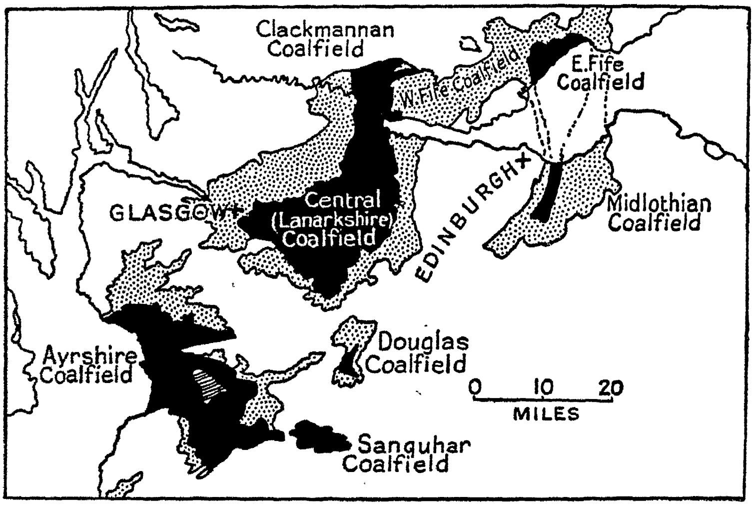


FIG. 169.—The Scottish Coalfields.

The Coal Measure fields are shown in solid black; the Carboniferous Limestone fields are dotted. All the fields are basins, wholly exposed except where the eastern field is covered by the waters of the Firth of Forth and where a patch of Permian occurs in the heart of the Ayrshire field.

Broadly speaking, the youngest rocks are near the centre of the syncline, the older rocks along its margins. Consequently there is a broad belt of Old Red Sandstone along the northern margin and a narrower, less continuous, belt along the south. Carboniferous rocks occupy the centre, but it is clear that folding and denudation had gone on before the formation of the Coal Measures and, at least in some cases, the Coal Measures occupy basins filling up old hollows in the pre-existing floor. Most of the ten more or less well-defined basins occupied by Coal Measures are, however, folds within Carboniferous rocks which have been formed by subsequent earth movements. The extent of the fields is roughly shown in the accompanying diagram, and broadly speaking it can be seen that there are three important areas:

(*a*) The Ayrshire coalfield.

(*b*) The Central coalfield, lying largely in Lanarkshire, but with extensions northwards into Stirling and Clackmannan.

(*c*) The Midlothian-Fifeshire coalfield, where actually the Coal Measures as well as the Carboniferous Limestone are continuous under the Firth of Forth which, however, divides this area into two fields, the one to the south and the other to the north.

Few of the Scottish coal seams have a wide lateral extent. This is particularly the case with the Lower Group. Further, individual seams tend to vary greatly in thickness, often within

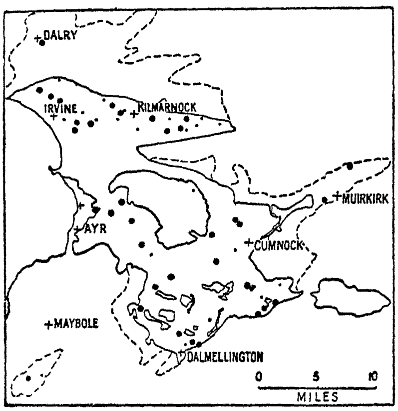


FIG. 170.—The Ayrshire Fields, 1931, distinguishing the Coal Measure fields from the here unimportant Carboniferous Limestone fields. One important colliery should have been shown in the Sanquhar basin.

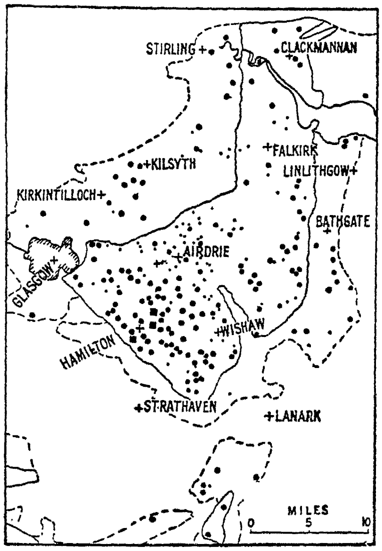


FIG. 171.—The Central Coalfield, 1931.

The rarity of large collieries employing over 1,000 men is remarkable. This map shows that the Carboniferous Limestone coals whilst important are not worked by nearly as many collieries as the Coal Measure coals.

short distances. Some of the best coals average under three feet in thickness, but locally the seams may swell out to over 20 feet. Most of the Scottish coals are bituminous coals, though first-class steam coals are present, and there are good bunker coals. There are, in addition, a number of good gas and coking coals.

(*a*) *The Ayrshire Field* is worked mainly in the north around Kilmarnock and Ardrossan, and the field as a whole has not given rise to extensive industrialisation.

(*b*) *The Central Field* is worked mainly north-east of the Clyde itself and the iron and steel industry, now depending largely on imported ore and pig iron, is concentrated in Airdrie, Coatbridge,

Motherwell, and Wishaw. Falkirk lies in the Stirlingshire extension of the Lanarkshire field. The ancient port of Bo'ness serves the Clackmannan coalfield by shipping coal and importing pit props.

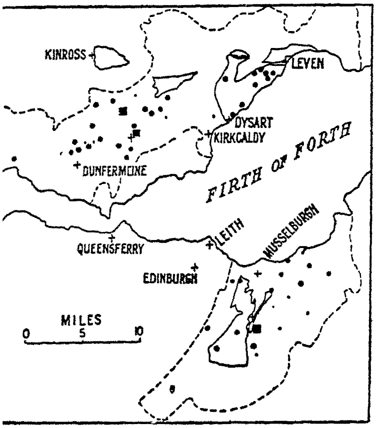


FIG. 172.—The eastern coalfields of Scotland, 1900.

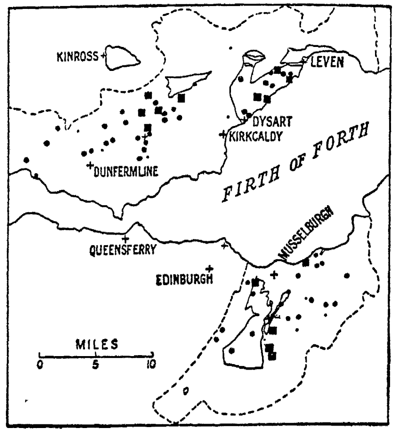


FIG. 173.—The eastern coalfields of Scotland, 1931.

The importance of the lower group (Carboniferous Limestone group) in Fifeshire is very apparent.

Clackmannan is still largely an agricultural county and the mine workings there do not unduly obtrude themselves.

(c) *The Fifeshire Coalfield* yields nearly a quarter of Scotland's annual production, and from the point of view of reserves occupies an even more significant position. Burntisland and Methil are both coal ports, and two of the chief industrial towns are Kirkcaldy and Dunfermline (see Chapter XXII).

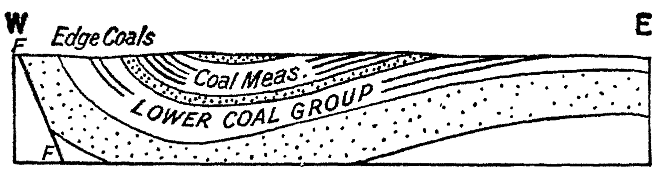


FIG. 174.—A section across the Midlothian Coalfield.

(d) *Lothian.*—The Lothian coalfield lies to the east of the capital. The coals of the Coal Measures are gently inclined, those of the Lower Series tend to be steeply inclined—almost standing on edge—hence the name Edge Coal Group.

Northern Ireland

Coalfields occur beneath the basalt rocks in a continuation of the rift valley of Scotland. There is a proved coalfield to the

immediate west of Lough Neagh, another one is believed to exist in the neighbourhood of Larne. One has also been proved to occupy a synclinal hollow in the old highland rocks in the neighbourhood of Ballycastle, and probably similar basins occur near Portrush. Actually, however, the present production of coal is negligible and the quality of proved seams is poor. Perhaps the greatest possibility for the future is the development of electricity from powdered coal at the mines.[1]

Eire

Although a geological map shows several areas of Coal Measures the coal seams in them are unimportant, and practically all the coal required by Eire has to be imported—mainly from Britain.[1]

THE UTILISATION OF BRITISH COAL

Great Britain produces something like one-sixth of all the coal mined in the world, and the diagram given here (Fig. 175)

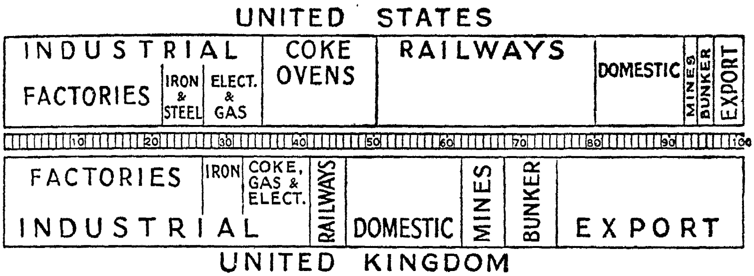


Fig. 175.—Diagram illustrating the utilisation of the coal mined in the United States and the United Kingdom respectively.

shows the uses to which British coal is put, contrasted with the use made of United States coal. This diagram shows that roughly one-third of all the coal mined is exported or supplied to ships as bunker coal. The quantity used by our railways, on the other hand, is relatively small. If one contrasts the United States, one notices the large proportion—more than a third of the whole—consumed by the railways and by contrast the relatively small quantity available for export. Both countries use between 40 and 50 per cent. of their coal for industrial purposes and for manufacture into coke. If one attempts also a comparison with Germany one finds that Britain is again unique in the proportion of coal which is destined for export.

[1] G. Fletcher: "The Power Resources of Ireland (Coal, Peat, and Water Power)," *Jour. R. Soc. Arts*, LXX, 1922, 604–616.
Commission of Inquiry into the Resources and Industries of Ireland: Memoir on the Coalfields of Ireland, 1921.

THE BRITISH COAL EXPORT TRADE

It has already been indicated in the last paragraph that an important percentage of the coal mined is destined for export or for bunker purposes. During 1914–18, when it was difficult for this country to export coal, many foreign countries tended to develop their own resources; or, if they had no coal, to push forward the development of water power. At the same time the world's output and utilisation of oil expanded enormously. Thus, when the War came to an end, Britain found her overseas markets much restricted. A table has been appended here to show the exports of coal from Britain in millions of tons in a pre-1914 year and post-1919 years.

EXPORT OF COAL FROM BRITAIN IN MILLIONS OF TONS

	1913	1927–29 (yearly average)	1930	1936
Russia	6·0	0·0	0·0	0·0
Finland		0·5	0·4	1·1
Sweden	4·6	2·0	1·8	2·7
Norway	2·3	1·4	1·2	1·3
Denmark	3·0	2·0	1·9	3·3
Germany	9·0	5·0	4·9	3·0
Netherlands	2·0	2·6	2·9	1·3
Belgium	2·0	3·0	3·4	0·5
France	12·8	10·4	13·0	7·1
Portugal and Azores	1·4	1·0	1·2	1·0
Spain and Canary Islands	3·6	2·5	2·1	0·7
Italy	9·6	6·8	7·2	0·1
Austria-Hungary	1·1	—	—	—
Greece	0·7	0·6	0·5	0·1
Rumania	0·3	—	—	—
Turkey	0·4	—	—	—
Algeria	1·3	1·6	1·4	0·9
Portuguese West Africa	0·2	0·3	0·2	0·0
Chile	0·6	—	—	—
Brazil	1·9	1·6	1·2	0·6
United States	—	0·3	0·4	0·1
Uruguay	0·7	0·4	0·3	0·3
Argentina	3·7	2·8	2·7	2·0
Irish Free State	—	2·4	2·5	2·5
Gibraltar	0·4	0·4	0·2	0·4
Malta	0·7	0·2	0·1	0·1
Egypt	3·2	2·2	1·8	1·3
Aden	0·2	0·1	0·0	—
India	0·2	0·0	0·0	—
Ceylon (Colombo)	0·2	0·1	0·1	—
Canada	—	0·7	1·0	1·3
Others	1·3	3·2	2·7	2·8
TOTAL	73·4	53·8	54·9	34·5
Anthracite	3·0	3·5	4·1	3·3
Steam	53·6	37·2	36·5	24·3
Gas	11·5	6·8	6·6	3·0
Household	1·8	1·8	1·9	1·5
Others	3·5	4·5	5·8	2·4

This table emphasises, first of all, the huge drop (50 per cent. or more) in the volume of exports. But it also illustrates at the same time that the diminution in the trade is not due to the disappearance of one or more customers, but to the decreased purchases of practically all. It is true that a new competitor in the export trade has arisen in Poland, and possibly the supplies of coal by Germany as part of the reparations payments may, to a small extent, have affected markets which might have purchased British coal. But these factors are small when the whole world position is considered. Then Britain has been specially severely affected by the competition of oil. The vessels of her own Navy and merchant fleet, as well as those of her former customers, have been largely converted from coal burners to oil burners. Not only is the quantity of bunker coal affected, but it must be borne in mind that much of the coal *exported* from Britain was destined eventually for use as steamship fuel. A glance at the figures for exports to the small coaling stations —naval, such as Malta, or general, such as Aden and Colombo— makes this clear. It is also very noticeable from the figures given at the bottom of the table that the bulk of the coal exported is steam coal. In fact it is possible to go down the table showing the list of Britain's customers and to append against each country the main cause for the diminution in the purchases. In those countries where water power has been extensively developed, *e.g.* Norway, Sweden, and Denmark—Denmark obtaining its hydro-electric power from Sweden—the drop in coal exports is very marked.[1]

Summarising, in the years before 1914 the proportion of British coal exported averaged 25 per cent., in the year 1913 a total of 73,400,000 tons having been sent abroad out of a total of 287,000,000 tons mined. In pre-1914 years another 9 per cent. of the output of the mines was absorbed as bunker coal. In the years 1927–31 (after the great strike of 1926) the average exported was 51,820,000 tons of a total mined of 242,000,000, representing 21·4 per cent. of the total, whilst the coastwise and bunker trade absorbed another 17,182,000 tons or 7·1 per cent. In 1931 the exports reached the very low level of 42,750,000 tons out of a total of 219,500,000 mined. In 1936 the exports were only 34,533,000 tons out of a total of 229,000,000 mined.

Taking the average of the years 1927–31, roughly 80 per cent. of the coal exported was from the South Wales and the Northumberland and Durham fields. The following table shows the chief ports concerned :

1. North-eastern England ports (Newcastle-on-Tyne ports, Blyth, Sunderland, and Middlesbrough)	17,819,800
2. Humber ports (Hull, Goole, Immingham, and Grimsby) . . .	4,612,600

[1] See B. Cunningham, "The Influence of Modern Hydro-electric Power Development on the British Coal Trade," *Nature*, CXXVIII, 1931, 397–8.

3. Bristol Channel ports (Newport, Swansea, Cardiff, etc.) . . .	22,005,100
4. North-west England ports (Liverpool, Manchester, Runcorn, Fleetwood, Workington, etc.)	1,272,600
5. East Scotland ports (Leith, Granton, Bo'ness, Grangemouth, Burntisland, etc.)	4,102,600
6. West Scotland ports (Greenock, Glasgow, Ardrossan, Troon, Ayr, etc.)	1,606,700

Two lessons stand out very clearly from this study of the coal export trade. The post-1918 depression in the coal industry is due far more to the drop in the export trade than to any diminution in home demands. Consequently the two great fields of South Wales and Northumberland and Durham which, largely as a result of their situation, supply the bulk of the coal for export, have been the ones to suffer most acutely from the depression. In the second place the diminished demand for British coal in many overseas areas must be regarded as permanent, and a return to pre-1914 conditions is impossible. There is thus the need for concentrating attention on those countries deficient in coal, deficient in other sources of power, and which must continue to require a considerable quantity. Of these Argentina, Brazil, and Chile afford good examples, as indeed does the whole of the South American continent.

THE FUTURE OF THE BRITISH COAL INDUSTRY

In the first place it must be clearly indicated that the British output of coal is by no means incompatible with the reserves, since the reserves possessed by this country are excellent. To a large extent the future of the British coal industry must be bound up with the utilisation of oil. Although there is at present a world over-production of crude oil, it is quite clear that this cannot go on because the immense strides made in the world production of oil have been dependent in the main upon the continued discovery of new fields, and in many cases a new field discovered has been very rapidly exploited and therefore correspondingly depleted of its reserves. Oil is a liquid and flows towards the wells from which it is pumped. A well or a field has actually gathered its resources from over a vast area, and the reserves of oil are likely to be used up within a comparatively small number of years. That, of course, will be the opportunity for the development of processes for obtaining oil from coal, most probably by the hydrogenation process—although there is a competitor in the low temperature carbonisation process. Low Temperature Carbonisation, Limited, has plants at Barugh (Barnsley), Askern (Doncaster) and Greenwich.

On July 17th, 1933, the Prime Minister announced in the House of Commons that the Government had decided to guarantee a preference of not less than 4*d*. a gallon to light hydrocarbon oils produced from British coal, shale or peat over their foreign competitors. The scheme was to last for 10 years from April, 1934. Imperial

Chemical Industries, Limited (see p. 523), immediately announced a scheme for the erection of a large plant at Billingham-on-Tees for the hydrogenation of coal, to obtain an initial output of 100,000 tons of petrol a year.

This work has been actively pursued, and suggests the salvation for the future—oil from coal—since the coal industry must face the permanent diminution in the foreign demand for British coal and an increase rather than a diminution in strength of competitors. The low cost of the adit mining, for example, in South Africa, when compared with the deep shafts of the British fields, must make this inevitable.[1]

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[1] E. C. Rhodes: *Jour. Roy. Stat. Soc.*, XCIV 1931, 487–539.

CHAPTER XVI

MINING INDUSTRIES OTHER THAN COAL

THE table already given at the beginning of the last chapter shows the comparatively small importance of mining industries other than coal. Coal accounts for 88 per cent. by value of the output of the mining industry of this country and iron ore, which is considered in Chapter XVII, another 1·7 per cent. All others thus represent only 10 per cent. of the total. All minerals of which the annual value is over £1,000,000 a year are non-metallic. Up to 1929, of the metallic minerals for which Britain was once famous, tin ore and lead ore were the only ones that remained of any considerable value. During 1930, 1931, and 1932[1] many of the mines producing even these metallic minerals were closed down (see pp. 412, 426). During the Great War, when it was of the utmost importance to know the home resources of all commodities, the Geological Survey undertook investigation of the British resources in metallic and other minerals. The results of the inquiries were published in a series of special memoirs on the mineral resources, and these volumes form a full and authoritative source of information. In view of the present situation of the metalliferous mining industries, the following notes are extremely brief.

METALLIC ORES

Although individual deposits may vary widely in details of their mode of occurrence most of the metallic ores found in Britain may be said to occur in one of three major types of geological environment.

(1) Associated with the granite masses of Devon and Cornwall there are innumerable veins carrying metallic ores.

(2) In most of the larger areas of Lower Palæozoic rocks of the Highland Zone of Britain, there are ore-bearing veins of various kinds. Their irregular distribution suggests that they are associated with igneous phenomena—the intrusion of masses of molten rock into the crust—of which there is not always evidence at the surface. The principal areas are Central and North Wales (including Anglesey), Shropshire, the Lake District, the Southern Uplands of Scotland[2] and the Wicklow Mountains of Ireland.

[1] In 1936, owing to the rise in the price of metals, there was renewed activity.
[2] In Galloway the ores are associated with the Cairnsmore of Fleet granite.

(3) In certain regions of the Carboniferous Limestone outcrop, ores of lead and zinc are frequently found in joints and solution-hollows. The southern Pennines of Derbyshire, the northern Pennines of Durham, Northumberland and north-west Yorkshire, the Mendip Hills and Flintshire are the chief areas.

Gold.—It is difficult to believe that two thousand years ago south-eastern Ireland, Wicklow, was famous as a gold-producing region, and that ornaments made from Irish gold were well known even outside that country. The sources of gold seem all to have been alluvial, and the streams from which it was panned have been exhausted. Gold mining achieved some little importance in North Wales,[1] but a recent exhaustive inquiry, presided over by Professor Louis, of Newcastle, negatived the possibility of future developments, although at the time much comment was attracted in the Press. Similarly, small quantities of gold have been panned from streams in Scotland—for example, in the Lead Hills.[2]

Tin Ore.[3]—It is said that the mineral riches of the Cassiterides (the Scilly Isles) attracted the Phœnician traders in the pre-Roman era. At a later date the workings on the mainland of Cornwall became extremely important. During the Armorican earth movements there were intrusions of huge granitic masses into the old rocks of Devon and Cornwall, and one of the latest stages in the igneous activity was the intrusion of veins and lodes carrying metalliferous ores, which are found particularly along the northern margins of the granitic masses. Tin and copper lodes generally run east-north-east and west-north-west; and whilst silver and lead ores occur as a later deposition in the same lodes they are more abundant in another series of lodes almost at right-angles. Tin ore is a very stable mineral and so is met with not only in veins or lodes in the rocks, but also washed out in alluvial deposits. The former is called " mine tin," the latter alluvial or " stream tin." The stream tin was naturally worked out at an early date in Cornwall, but tin ore is curiously restricted in its world distribution so that the south-western peninsula continued to be almost the sole source of supply of this metal until the last 200 years, and until a few years ago was still the only important place of production in Europe. The chief sources of the world's supply are now the rich deposits of the Federated Malay States and the nearby islands of Banka and Belitong in the Dutch East Indies, or the adjoining parts of Siam and Lower Burma, together with Bolivia in South America, and Nigeria. The importance of

[1] Especially round the Harlech Dome.

[2] On this and on the mineral resources of Scotland in general, see Heddle's *Mineralogy of Scotland*. Ed. J. E. Goodchild. 2 vols. Edinburgh: Douglas, 1901.

[3] W. S. Lewis: *The West of England Tin Mining.* Exeter: Wheaton 1923.

tin is, of course, in the tin-plating industry (see p. 375). In the south-western peninsula the industry was to a large extent concentrated around the mining towns of Camborne and Redruth. A graph has been drawn to show the decline in the industry in this country (Fig. 205); but the Cornish mines for several generations now have formed a school from which miners have gone to all parts of the world; and by no means a small proportion of the tin-mining companies of the Far East and elsewhere still have their offices or headquarters in the two small mining towns of Cornwall. In 1928 there were still about twenty mines operating in Cornwall, but most of them suspended or abandoned operations towards the close of

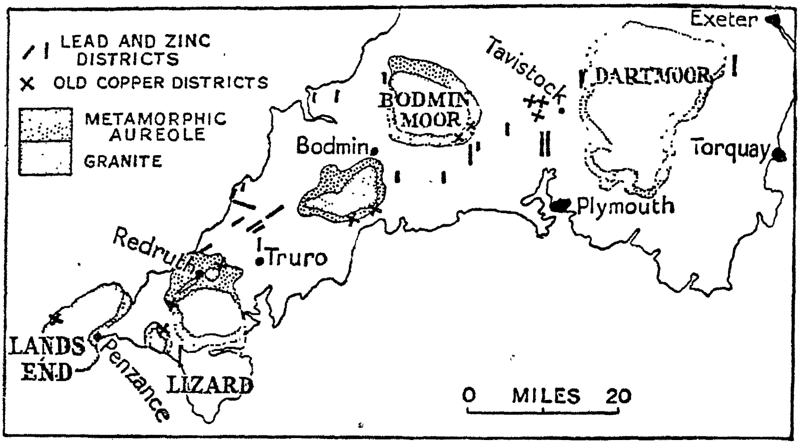


FIG. 176.—The metalliferous mineral areas of Cornwall and Devon.

The tin mining tracts corresponded approximately with the copper districts. (*From Mineral Resources, Vols. XXI and XXVII.*)

that year or in 1929 and 1930. In 1932 there were none still in operation, but some reopened, and in 1934–35 the output was worth £400,000, in 1937, £435,000, and in 1938, £349,000.

Copper.—Copper was probably mined in Britain in pre-Roman times, and some areas were of very considerable importance in the Middle Ages; but the production of copper in England from home ores has greatly declined since 1840, whilst there has been a corresponding growth in the import of foreign ores and ores which have undergone some preliminary treatment. In 1931, according to the official List of Mines, there were only three men employed in copper mining in this country. The most important area for copper mining was Devon and Cornwall. In the early nineteenth century 7½ per cent. of the world's copper came from this region and production went on increasing until about 1860, after which it fell rapidly. The copper ores were usually found in the east-north-

east to west-south-west lodes associated with the granite masses. There were five main productive areas :

(1) The St. Just and St. Ives areas of the Levant mines.
(2) The Carn Brea granite mass, where the chief active mines were situated until recently.
(3) The St. Austell area.
(4) The south-east of the Bodmin Moor granite.
(5) The Tavistock area.

Tin and copper were not usually found together, though sometimes in different parts of the same lode. There is a tendency for the tin to occur where the lodes pass through granite, and copper where they pass through the slate or killas. The chief copper ore in Cornwall was chalcopyrite and usually in the lodes three zones

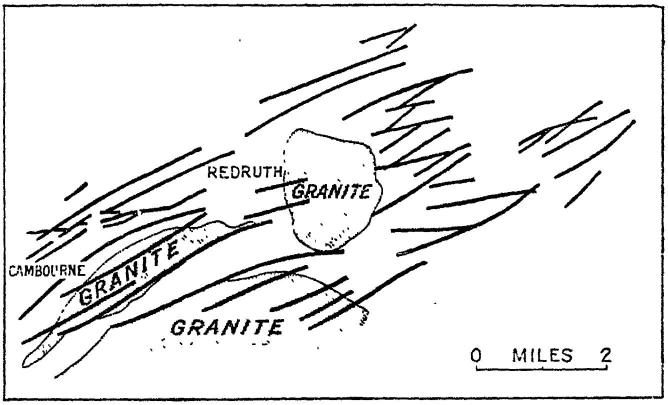


FIG. 177.—Sketch map showing the disposition of the tin and copper lodes in the Cambourne-Redruth district, relative to the granite masses.

(*From Mineral Resources, Vol. XXVII.*)

were distinguished: an upper zone where the ores had been oxidised, a middle zone where the sulphides had been secondarily enriched, and the third lowest zone of primary sulphides. The exhaustion of the middle zone of secondary enrichment meant working poorer ores at a greater depth, and these in turn tailed out. Hence there was not only a deterioration in quality of ore with depth but eventually an exhaustion. Some idea of the former importance of the industry may be gathered from the fact that from the St. Just area alone something like 40,000 tons of pure copper has been obtained.[1] Outside Devon and Cornwall the chief copper mine was at Ecton, in Staffordshire. This mine, though abandoned in the early nineteenth century, had probably up to that date produced some 60,000 tons of ore, the ore occurring as masses in Carboniferous Limestone. The other great area was

the Parys area, in Anglesey. There were also famous mines in the Lake District—in the Coniston, Keswick, and Caldbeck areas—as well as in various parts of the mainland of Wales, in Carmarthenshire, Merioneth, and along the Welsh border.

Lead and Zinc.—Lead ores have been mined in a number of localities in the British Isles. Sometimes they are associated with the zinc ores, but zinc has never been of anything like the same importance. Frequently the lead ores are argentiferous. In many parts of the British Isles the lead ores were worked in Roman and pre-Roman times, and it was quite clear that the lead of the British Isles was a definite attraction to the Romans and for a time, at least, was Britain's chief export.[1] In the important area of the south-western peninsula the chief producing tracts were the Truro—Newquay area, Liskeard, and Tavistock. Lodes carrying lead ores never occur in granite and seldom in the metamorphic areas surrounding the granite. The lead-bearing lodes are instead found in sediments, and the ores tend to be associated particularly with north-south lodes. The ores are notably rich in silver, averaging about four ounces to the ton. The lead ores occur especially in the upper part of the lodes, hence the working out of the deposits as they are followed downwards. In the Mendip Hills lead was definitely worked in Roman and pre-Roman times as well as through the Middle Ages. In the last century the maximum output was reached in 1871. In the Pennines there are three mineralised areas: in Derbyshire, in north-west Yorkshire and in Durham. Most of the lead and lead-zinc deposits are in the Carboniferous Limestone and occur in fissure veins. Probably the Romans worked lead in this area. One of the richest areas is the Alston Moor-Allendale. Other areas which have been worked are the Tyne area between Corbridge and the Allen river, the Derwent valley and Devil's Water, the Nent and South Tyne valleys, and the Upper South Tyne next to Cross Fell. Other areas where lead has been worked include the Carboniferous tracts in North Wales, as well as in pre-Carboniferous rocks in North Wales, in the Cambrian, Ordovician, and Silurian—nearly always associated with faulted areas. There were formerly many mines in northern Cardiganshire and the western part of Montgomeryshire, whilst the Shelve district of Shropshire was a well-known one. In Scotland the Lead Hills and Wanlockhead area was particularly important. Tables of quantities given in Chapter XIX (p. 426 and Fig. 204) show the relative importance of lead mining at the present day.[2]

[1] Lead was of great importance to the Romans in connection with their numerous water supply schemes. The Roman invasion of Britain was in 43 A.D. By 49 A.D. the export of lead from Britain was so great that Roman colonists in Spain were petitioning against the competition. It is noteworthy that Hadrian's Wall marks the northern boundary of the Pennine lead-fields.

[2] Value of lead ore produced in 1938, £355,000. See also p. 412*n*.

NON-METALLIC MINERALS

The heavy minerals, *barytes* and *strontianite*, used for the "filling" of first-class papers, are mined or quarried in certain limestone areas, notably Derbyshire. *Fluorspar*, used as a flux in the smelting of certain ores and in the manufacture of hydrofluoric acid for glass-etching, is also obtained in limestone districts, particularly Derbyshire. *Gypsum*, which, when robbed of the greater part of its contained moisture, is ground to form plaster of Paris, has maintained a considerable importance and is found principally in seams in the upper part of Triassic rocks, as in Nottinghamshire near Newark and in the Tees basin area of South Durham. The extraction of *oil* from *oil shale* was for long an important industry in Scotland, particularly in the region to the west of Edinburgh, where some of the richer shales yielded as much as 80 gallons per ton. When the richer shales were exhausted the yield dropped to about 20 gallons per ton. By-products became more valuable than the oil and wax obtained—despite the manufacture of candles. Large quantities of ammonia were obtained which, combined with sulphuric acid made on the spot to form ammonium sulphate, yields a valuable manure.[1]

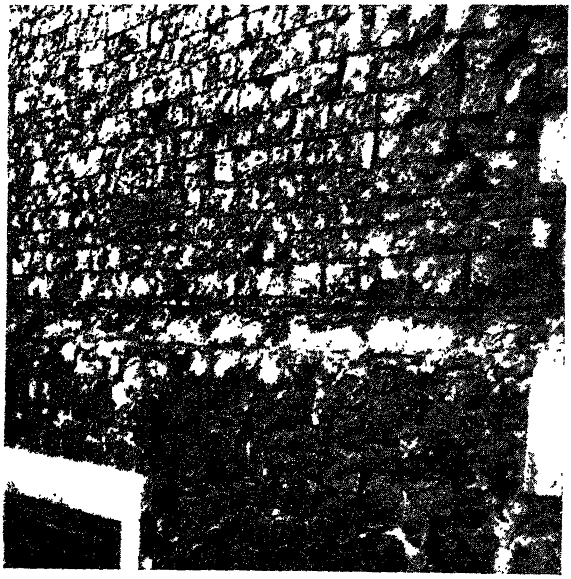
Salt is mainly obtained (see pp. 522, 523) in the Cheshire salt field and in South Durham, and has formed the basis in those two areas of the important chemical industry.

Slate obtained from certain beds or seams amongst well-cleaved ancient rocks was formerly very extensively quarried in North Wales, particularly at Blaenau Festiniog and in other parts of the Snowdon range, at Delabole in Cornwall, and in the Lake District; but the modern vogue for tiled houses rather than slated houses has affected the industry somewhat severely.

Of the different types of *clay* which are obtained some interest attaches to the ordinary clay dug for brickmaking. Formerly brickmaking was practised from small brickyards all over the country, but of recent years there has been a marked concentration of the manufacture of bricks in a few well-marked areas many of which use Oxford Clay—for example, the great tract some four or five miles south of Peterborough on the main London and North Eastern line and similar developments near Bedford and Bletchley. Peterborough alone produces over 1,000,000 tons of bricks per annum. Grey clays for the manufacture of rough earthenware and pottery form the basis of the pottery industry of the North Staffordshire coalfields (see p. 531); but for the china-making industry of

[1] See *Scottish Oil-Shale Industry*, Command 2538. H.M.S.O., 1925. In 1931 there were still 2,640 men employed in Scottish oil-shale mines. Oil shales occur in the Jurassic rocks of England, but have not repaid attempts at utilisation. See E. Clarke: *The Jurassic Oil Shales of England.* Thesis for degree of Ph.D. (University of London), unpublished, 1928.

the same area the *china clay* is obtained chiefly from Devon and Cornwall. There it occurs in irregular pockets in the surface of the granite masses, and there has been considerable discussion in scientific circles as to whether it is due to a certain form of weathering of the granite or whether it is due to what is called pneumatolytic action by gases rising from the interior of the earth's crust and decomposing certain minerals of the granite. Whatever its origin, the clay is dug out in deep pits, is washed to free it from fragments of quartz and other impurities, and the finally washed and dried pro-



[*Photo: L. D. Stamp.*

FIG. 178.—Two types of flint work in an old building in East Anglia (Norwich).

An excellent example of the former general use of local materials for building. The beautifully trimmed flints used for the upper part of this wall involved immense labour in their preparation, and supply the main reason for the disappearance, in most parts of Britain, of "traditional" building materials and the substitution of bricks.

duct is bagged and is exported from a number of small ports conveniently situated for the Cornish mines. Of these the most important are those in the neighbourhood of St. Austell. Some china clay is sent abroad, but a larger proportion taken by the British china manufacturing industry, the china clay being sent by water to the Potteries coalfield. Ball-clay and fine pipe-clay, such as those of Dorsetshire occurring in the neighbourhood of Poole, are also utilised; whilst the pottery industry (see Chapter XXIV) requires quantities of *felspar*, and of *flints* which are obtained as a by-product in the quarrying of chalk. *Fireclays* occur particularly in the Coal Measures, quite frequently underlying the seams of

coal in the Lower Coal Measures. Fireclay is mined for the manufacture of bricks resistant to heat, *i.e.* refractory bricks for the lining of furnaces. Sometimes silicified fireclays or underclays known as *ganister* occur naturally and are quarried for the same purpose, again particularly in the Lower Coal Measures.

Mention must be made of the extensive quarries of *gravel* for the building industry and of *sand* for similar purposes. Certain special types of sand which stand up well to form moulds are required as moulding sands in the iron industry. Particularly famous amongst these are the red moulding sands of the Midlands, such as those obtained at Mansfield in Nottinghamshire.[1] Very different types of sand, which consist of almost pure quartz free from other minerals, are required for the glass-making industry. They are not of wide occurrence in this country, but glass-making sands have been quarried at Aylesford in Kent from the Lower Greensand, and also in the neighbourhood of Leighton Buzzard in Buckinghamshire.[2] Amongst natural building stones some of the most important are the *freestones*, so called because they may be cut freely in any direction, of Bath and Portland. These are limestones belonging to the Oolitic series (Jurassic) and are still of very considerable importance. Somewhat similar are the Magnesian Limestones which, as a rule, are more resistant to weathering, though curiously enough where they have been used in the sulphurous atmosphere of towns, as in London, they have suffered extremely badly. *Sandstones* are also important building stones, especially some of the Coal-Measure and Millstone-Grit sandstones for local use, and the pleasant red sandstone of Penrith and several Old Red Sandstone areas. *Granites* are also quarried as building stones, particularly in the north in the Peterhead and Aberdeen areas (Aberdeen, of course, being known as the Granite City). The Shap granite of the Lake District area is a famous one because of its large pink felspar crystals, whilst some of the granites of the south-western peninsula have been utilised for similar purposes.[3] The amazing progress made in the improvement of British roads, especially since the War, has given rise to an ever-increasing demand for *roadstones*. For this purpose many slags from blast furnaces are utilised as well as natural stones. It is interesting that in the south-east of England, where there is a great demand for road metal, suitable hard rocks are absent, so that at the nearest points at which they occur, for example amongst the ancient rocks of the Charnwood Forest of Leicestershire, there

[1] P. G. H. Boswell: *A Memoir on British Resources of Moulding Sands* London: Longmans, Green & Co.

[2] See P. G. H. Boswell: *A Memoir on British Resources of Sands and Rocks used in Glass-making*. London: Longmans, Green & Co., 1918. Whilst a variety of sands can be used for bottle glass, very pure sands are needed for better types.

[3] See J. V. Elsden and J. A. Howe: *The Stones of London* (Colliery Guardian Co., 1923); and J. A. Howe: *Geology of Building Stones*. London: Arnold.

is a very big demand indeed. In the Highland Zone of the British Isles, of course, there are many suitable stones which are widely quarried. Igneous rocks are particularly suitable, including, for example, the "dhu" stone of Staffordshire, Shropshire, etc., which is really a basalt. For centuries many limestones have been burnt for the manufacture of *lime*, but the pure white limestone chalk is particularly suitable for this purpose. Even more significant, however, is the manufacture of *Portland cement*. It was Joseph Aspdin, a Leeds bricklayer, who, in 1824, took out a patent for what he called Portland cement, made by combining a mixture of limestone and clay. So rapidly has the industry grown that within a hundred years 60 million tons of Portland cement are being made annually in the world. It will be seen that the raw materials of this industry are limestone, clay or mud, and a fuel for the factory. Hence there is a concentration of the industry at points on navigable water and where both the clay and the limestone are available. Along the lower Thames there are enormous quarries between Dartford and Gravesend from which the chalk is obtained, whilst the mud or clay is dredged from the Thames. Thus two birds are killed with one stone—channels for steamers are kept clear, and raw material is provided for the industry. In some cases clay is quarried in the hills above, mixed with water, and passed through pipes as a sludge to the waterside factories. There are also many inland centres, a notable localising factor being rail transport. Thus the hydraulic limestones of the Lower Lias are used (*e.g.* Rugby, Harbury), the Lower Chalk of the Chilterns (Luton, Dunstable), the Lincolnshire Limestone of Ketton (Rutland)—one of the largest producing units in the country—the Carboniferous Limestone (*e.g.* Cracoe Knolls country) and the Magnesian Limestone (*e.g.* Ferryhill area, co. Durham).

REFERENCES

For an account of resources, see the series of memoirs published by the Geological Survey on Mineral Resources.

CHAPTER XVII

IRON AND STEEL[1]

HISTORICAL: THE DEVELOPMENT OF THE IRON AND STEEL INDUSTRY

THE origin of the British iron industry is lost in obscurity. The five hundred years before the Christian era, however, are known as the Iron Age, and in all probability the Celtic inhabitants of Britain were fairly expert in the working of the metal; the finding of Celtic pottery in association with iron slags in the Furness[2] district and near Northampton[3] is evidence of at least two localities in which the actual smelting was performed. That the Romans worked the iron ores of our islands is also quite certain. Sites of furnaces and heaps of slag lying near accumulations of Roman coins and pottery have been identified in Furness, in the Forest of Dean, in the Weald, in the Mendips, in Northumberland and Durham, in Northamptonshire, and in South Wales.[4] The earlier furnaces were usually situated in exposed places, where the wind would create a natural blast; later, sites were chosen along streams where a small water-wheel could be used to work the primitive bellows. After the Roman occupation there are few records and, apart from a few scattered notices in the Domesday Survey,[5] where "ferraria" (ironworks) are occasionally mentioned, we have no positive information until the twelfth century.

The two most important medieval centres of the iron industry were the Forest of Dean and the Weald of Sussex and Kent.

(1) *The Forest of Dean.*—This was for long the chief area in the country for iron smelting.[6] As early as 1282 there were sixty

[1] By S. H. Beaver. The authors are greatly indebted to Sir William Larke and Mr. M. S. Birkett, O.B.E., Director and Secretary, respectively, of the National Federation of Iron and Steel Manufacturers, for valuable criticism and comments on this and the following chapter as they appeared in the first edition.

[2] G. M. Tweddell, *Furness Past and Present.* 1876.

[3] *Victoria County History,* Northamptonshire, I, 151.

[4] Kendall: *Iron Ores of Great Britain and Ireland.* Crosby, Lockwood. 1892. Chapter II. More detailed references will be found in the volumes of the *Victoria County History, e.g.* Cumberland, II, 385–406; Durham, II, 278–293; Yorkshire, II, 341–351; Lancashire, II, 360–364; Derbyshire, II, 356–362; Gloucestershire, II, 216–233; Worcestershire, II, 267–271.

[5] *E.g.* Gloucestershire, in the Forest of Dean, and at Pucklechurch; Northamptonshire, at Gretton and Corby; Yorkshire (East Riding), at Hessle.

[6] See H. G. Nicholls, *Iron Making in the Olden Times.* 1866.

forges in the forest using the local ore, and the industry continued to flourish for many centuries. In the seventeenth century the area was importing richer ore from Lancashire to supplement the local supplies and was sending iron to the Birmingham area for working up into implements and weapons.

(2) *The Weald of Sussex and Kent.*—In the sixteenth and seventeenth centuries this area was even greater than the Forest of Dean in the importance of its iron industry. The first cast-iron guns were made at Buxted in 1543, and a large proportion of the British ordnance was subsequently made in the Weald. In 1574 there were

[*Photo: L. D. Stamp.*

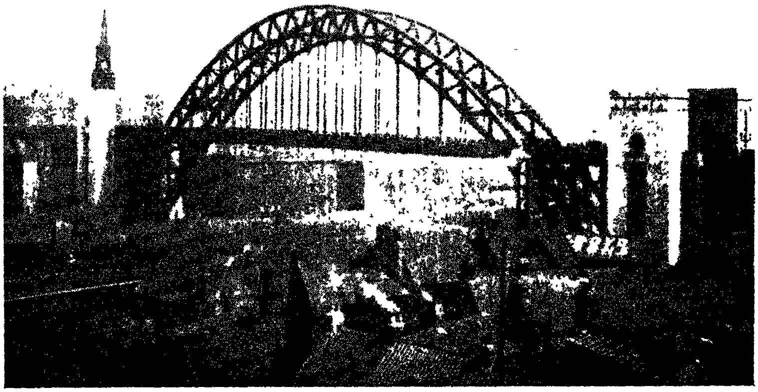
FIG. 179.—The first iron bridge, constructed across the River Severn in 1779. The bridge was still in daily use until recently, but is now scheduled as an ancient monument and closed to all traffic. The town is known as Ironbridge.

no less than 32 smelting furnaces and 38 forges in Sussex, besides numerous others in Kent.[1]

In addition we have definite records of iron making in Northumberland and Durham from the thirteenth century onwards, in Northamptonshire and Lincolnshire in the twelfth and thirteenth centuries, in the West Riding of Yorkshire from the twelfth century, and in Rosedale (North Riding) in the fourteenth century, in Cumberland and in Derbyshire from the twelfth century, in the Furness district from the thirteenth century, and in South Wales

[1] See W. Topley, *Geology of the Weald*, 1873 (H.M.S.O.); also E. Straker, *Wealden Iron*, 1931 (George Bell); and M. Delany, *The Historical Geography of the Wealden Iron Industry* (Benn), 1921.

from the fourteenth century, together with evidence of the existence and working of iron ore in certain other localities. In fact, during the medieval period, the iron industry in Britain was fairly widespread. Two factors contributed to this. First, the abundance of iron ore near the surface in many parts of the country, and second, the ample timber supplies which could nearly always be found in the vicinity of the ore deposits. So great was the amount of charcoal necessary, however, that the forests were being rapidly depleted,[1] and in the reign of Queen Elizabeth stringent measures were passed to prevent the reckless destruction of our timber supply



[*Photo: S. H. Beaver.*

FIG. 180.—One of the latest steel bridges, constructed across the River Tyne at Newcastle.

This bridge is similar in design to the new Sydney Harbour Bridge, Australia, constructed by the same firm.

at a time when every log was valuable for building ships of war. Only those areas, then, which were especially favoured by extensive forests, as the Weald and the Forest of Dean, were able to maintain their industry on a large scale; for, however rich a deposit might be, overland movement of the ore was impracticable except for short distances when pack horses were the only means of transport available. The Cumberland and Lancashire region, lacking exten-

[1] It is probable that an acre of woodland yielded only sufficient charcoal to make three tons of iron, and as a single furnace in the sixteenth century could make 20 tons a week it is obvious that the destruction of the forests must have been very rapid.

In 1784 Henry Cort perfected the puddling furnace for making malleable or wrought-iron, using coal as fuel. He also introduced the use of rollers in place of hammers in drawing out the iron into bars. These processes provided a further stimulus for the iron industry by enabling much larger outputs to be obtained in very much less time than formerly, and they helped to strengthen a

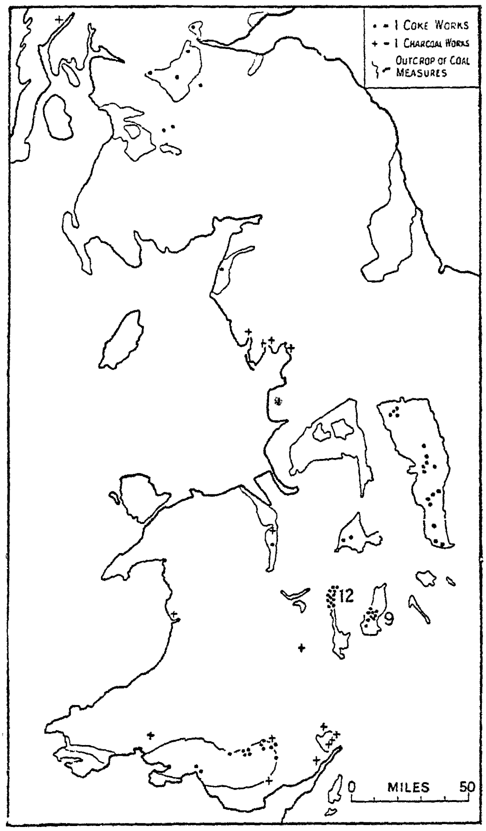


FIG. 181.—Blast furnaces in 1796.

Exposed coalfields outlined. The last of the Wealden furnaces, at Ashburnham, is not shown on this map. Note the absence of furnaces in south Lancashire and north-eastern England.

movement which had been going on for twenty years, namely the increasing concentration of the ironworks on the coalfields. Progress was not rapid—in 1788 nearly half the furnaces in Britain were still using charcoal—but slowly and surely the pull of those areas which were favoured with abundant iron ore in the same measures as the coal seams was beginning to assert itself.[1] By

[1] The oft-repeated statement that limestone was an important localising factor has no foundation. The occurrence of limestone (*e.g.* at Dudley, Staffs, in Wear-

1806 only 11 charcoal furnaces remained out of the 300 or so that existed 150 years earlier, and the clustering of the ironworks round the coalfields of South Wales, South Staffs, Salop, and Derby was very marked. The coalfields of Northumberland and Durham and South Lancashire, however, being almost devoid of Coal Measure ironstones (see Fig. 186), failed to develop extensive iron industries at this time.

The iron industry also received a considerable fillip during this period from the waging of wars, which necessitated large supplies of iron weapons and ammunition. The American War of Independence occupied the years 1776–80, and between 1793 and 1815 wars were almost continuous on the Continent. These wars not only stimulated our iron industry, but by ruining the greater part of Europe placed Britain in a very strong commercial position.[1]

The first half of the nineteenth century was a period of gradual expansion and of improved technique in the iron industry.[2] Two events are important. In 1828 Neilson, a Glasgow gasworks foreman, suggested the use of hot, instead of cold, air in blowing the furnace. This process, which reduced the fuel consumption considerably, gave a remarkable fillip to the industry in Scotland, and was later taken up in England.[3] Then in the 'forties came the "railway mania," which created an enormous demand for rails and locomotives. The first locomotive had been built in 1812 by Blenkinsop, and the Stockton and Darlington Railway was opened in 1825; but the years 1845–7 marked the great boom in railway development.

Throughout the period since the introduction of coke fuel the ores of iron used in Britain had been of the clayband and blackband [4] types occurring in the Carboniferous rocks, together with smaller amounts of hæmatite from Cumberland and Furness. In 1851 the pig-iron production of Britain stood at the level of about 2½ million tons (which was half the world's supply) of which the greater part (*c.* 2·1 million tons) came from three areas, Scotland, South Wales, and South Staffordshire. It is not surprising, therefore, to find that the Coal Measure ores, especially in the Midlands,

dale, and on the edge of the South Wales coalfield) was an asset, undoubtedly, in reducing production costs by preventing the necessity for import from a distance; but the coal and ironstone measures were the real localising factors, and the industry would have developed thereon even if limestone had not been so favourably placed.

[1] L. C. Knowles: *Industrial and Commercial Revolutions of the 19th Century*, 1927, p. 102.

[2] 1816, Rogers' improved puddling furnace; 1842, Nasmyth's steam hammer; 1845, first attempt to utilise waste blast-furnace gases for heating blast and raising steam.

[3] See, with reference to this and to the matter of the preceding paragraphs, H. Scrivenor, *History of the Iron Trade*, 2nd edition, 1854.

[4] Blackband was not discovered till 1801, and not extensively employed until after the introduction of the hot-blast.

where working had been going on continuously for over a century, were beginning to show signs of a decreasing yield, due not so much to actual exhaustion as to the increased cost and difficulty of working the seams of nodules at a considerable depth. At this juncture, however, an entirely new source of ore supply was discovered [1] in the belt of Jurassic scarplands which stretches across England from the Cleveland Hills to the Dorset coast. These ores, first worked in North Yorkshire about 1850, and in Northamptonshire a year or two later, have had far-reaching effects upon the development of the British iron and steel industry, and their importance is difficult to over-estimate. The commencement of iron smelting in Cleveland and Northamptonshire marked the beginning of a decline in that great attraction which had been exercised by the coalfields ever since the introduction of coal as a fuel in the process of smelting. When every ton of pig-iron needed eight tons of coal to smelt it the setting up of furnaces away from the coalfields was obviously not an economic proposition. But with coal consumption reduced to two or three tons and the use of the Jurassic ores entailing an ore consumption of about the same amount, it became possible for the costs of coal and ore transport to be reduced almost to level terms, and at once the pull of the coalfields began to decrease in strength. The seaboard situation of Cleveland, together with the nearness of the Durham coke supply (*vide infra*, p. 356), sent this area forging far ahead of the inland Northamptonshire, where coal was at least 60 miles away.

The second half of the nineteenth century witnessed remarkable progress in the heavy metallurgical industry of Britain, a progress which was intimately bound up with the substitution of steel for wrought-iron. Huntsman's crucible furnace, invented in 1742, had for over a century been the only efficient means of producing steel, and this was a very costly process. In 1855 only about 50,000 tons of steel were produced in Britain at a cost of £75 per ton. In 1856 Bessemer introduced his "converter," which, making use of the heat generated by blowing a blast of air through a ladle of molten pig-iron, without the employment of the large amount of fuel consumed in the crucible method, could produce much larger quantities of good steel in a much shorter time (about 20 minutes only) at much less expense. Indeed, by 1864 the price of a ton of open-hearth steel rails had been reduced to £17 10*s.*[2] Almost on the heels of Bessemer came the Siemens brothers, who in 1861 patented the "open-hearth" type of regenerative furnace for steel making. As with most revolutionary inventions, however, it took many years for the new steel processes to become firmly set, and nearly 30 years

[1] Or rather rediscovered, for, as we have seen, Roman and medieval workings are known to have existed in Northamptonshire, Lincolnshire, and North Yorkshire.

[2] See Lowthian Bell: *The Iron Trade of the United Kingdom*, 1886, p. 20.

elapsed after Bessemer's invention before steel finally succeeded in surpassing wrought-iron as the chief product derived from ferruginous ores. Until the early 'eighties, in fact, the enormous demand for iron rails and iron ships was accompanied by a correspondings rapid increase in the size of the puddling industry and the number of puddling furnaces rose from 3,462 in 1860 to 7,575 in 1875.[1] Moreover, except in certain cases, the steel industry was hampered by the necessity, in both the converter and open-hearth processes (which employed acid, or silica, furnace linings), for fairly pure, non-phosphoric ores, such as occur in Britain only in Cumberland and North Lancashire. The bulk of British ores, including the Jurassic ironstones, were useless for steel making, and thus we find a new feature introduced into the British iron and steel industry, namely, the import of large quantities of rich non-phosphoric ores from Northern Spain into those steel-making areas such as Cleveland and South Wales, which were either on the coast or had easy access thereto. In 1869 scarcely 1 per cent. of the ore used in Britain was imported. In 1882 this figure had risen to 18 per cent.

The invention in 1879 by Messrs. Thomas and Gilchrist of the "basic process" (*i.e.* lining the steel furnace with a basic material such as dolomite, in order to get rid of the phosphoric impurities) might have been expected to change this state of affairs, since it permitted the use, for steel working, of the abundant phosphoric ores in the Jurassic rocks of Cleveland and the south-east Midlands. But the basic process, needing special furnace linings and entailing the payment of high royalty charges, was more costly than the acid process; and so cheap were the rich foreign ores that it was actually less expensive, at Middlesbrough, to convert rich Bilbao ore into steel rails by the acid process than to manufacture iron rails without conversion into steel from the lean phosphoric ore of the Cleveland Hills only a few miles away.[2]

Whether acid or basic, however, the production of steel rapidly increased in the last quarter of the nineteenth century, and steel began to be used for almost every purpose to which puddled iron had previously been applied—of which the most important were for rails, ships, and in constructional engineering.[3] But whilst

[1] See Lowthian Bell: *The Iron Trade of the United Kingdom*, 1886, p. 20.

[2] Lowthian Bell, *op. cit.*, p. 17.

[3] *Note on Iron and Steel.*—Pig-iron—or cast-iron—from the blast furnace is not pure. It contains carbon, and, if made from certain classes of ore, may contain sulphur and phosphorus; all these three elements are injurious and render the iron brittle. The carbon may be eliminated by stirring the molten iron in a puddling furnace; as the carbon disappears the liquid becomes pasty and is removed in lumps to be hammered or rolled. This is wrought-iron, very tenacious but not hard enough for many purposes. The acid process of steel-making so effectively removes the carbon that a small proportion has to be replaced by the addition of ferro-manganese or spiegeleisen, which contain some carbon. Steel may contain

British production of iron and steel continued to expand, our position relative to the rest of the world exhibited a slow decline. Between 1850 and 1870 Britain was producing every year about one-half of the world's output of pig-iron. The expansion of the

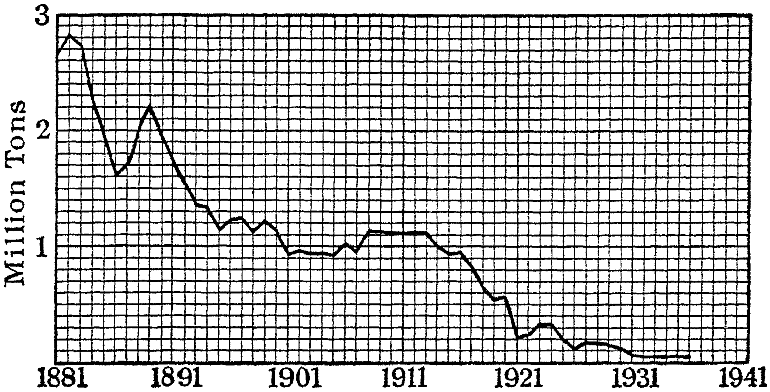


FIG. 182.—Production of wrought-iron.
(1937, 0·08 mn. tons; 1938, 0·05 mn. tons.)

industry in the United States, however, and the great development of basic steel in France and Germany, considerably reduced Britain's supremacy, and by the early 'nineties the United States and Continental Europe had each exceeded the British output, and the home country produced less than one-third of the world's pig-iron. By

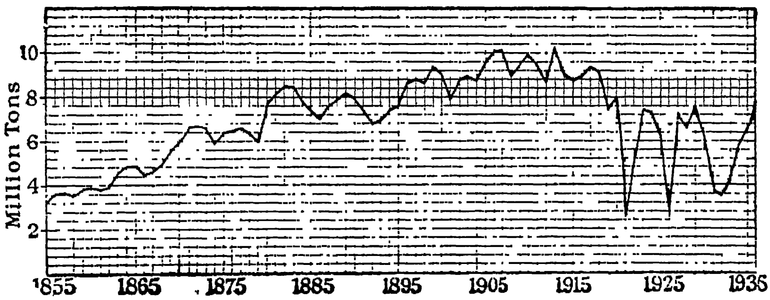


FIG. 183.—Production of pig-iron.
(1937, 8·5 mn. tons; 1938, 6·8 mn. tons.)

1913 we were producing only one-eighth of the world's total (10 million tons out of 78 million tons), and the United States and Germany had both passed our production by a considerable margin.[1] The tale of the steel industry is similar. Before the introduction

0·3 to 2·2 per cent. of carbon; it becomes exceedingly hard when cooled suddenly, and it is more flexible and elastic than wrought-iron, although not so durable when exposed to the weather. (Cf. Diagram on p. 338.)

[1] Germany, 16·76 million tons; United States, 30·97 million tons.

of the basic process Britain was easily first, but thereafter Germany (using the basic process with Lorraine ores) and the United States (using the acid process with Lake Superior ores) began to develop rapidly, and by 1913 Britain was producing little more than one-tenth of the total world output[1] (7·7 million tons out of 75 million tons).

The period from the commencement of the supremacy of steel until the Great War is characterised first by the great absolute expansion of the steel industry both at home and abroad, with the relative decline of Britain amongst the other great steel-producing nations; and secondly, by vast improvements in the technique of smelting and steel production, entailing a more efficient use of all apparatus and raw materials employed, and especially a considerable reduction in fuel costs. A third feature of note is the concentration on the open-hearth process at the expense of the Bessemer converter. The open-hearth furnace,

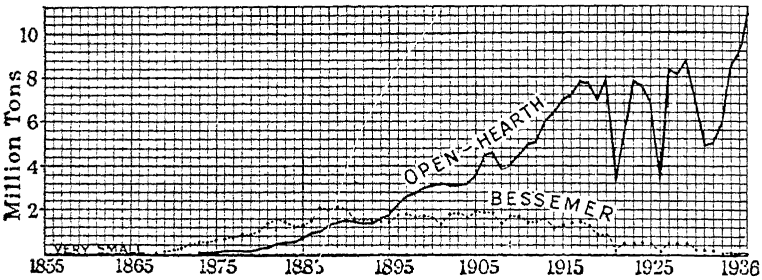


FIG. 184.—Production of steel.
(1937, O.H., 11·9; B, 0·7; 1938, O.H., 9·4; B, 0·6.)

although taking a longer time (some 6–10 hours) to convert pig-iron into steel, permits of greater control of its contents, and so the production of more carefully graded and uniform steel and, moreover, it allows the employment of scrap-iron, a very important economic consideration at the present time.[2]

The war of 1914–18 found the British steel industry ill-adapted for prompt adjustment to the tasks which had to be performed as a result of the phenomenal demand for steel of all grades. It may be said—whilst endeavouring to avoid making statements of too sweeping a nature—that the iron and steel works, while efficient, were not as productive as they might have been. This was no doubt due very largely to our early start in the industry and to our abundant supplies of fuel and of ore, whether native or water-borne from foreign countries. Britain performed the pioneer work and foreign nations, making use of our hard-earned experience, established their own industries on a more efficient basis. Moreover,

[1] See tables on pp. 113–14 of *Survey of Metal Industries*. H.M.S.O., 1928.

[2] On an average some 40–50 per cent. of the raw material of the steel industry consists of scrap, but in individual furnaces the percentage may rise to as much as 80.

our foreign competitors had not the same advantages of cheap fuel and ore supplies in close proximity, and consequently they had to put forward every effort to counterbalance their heavy fuel and transport costs by a high degree of efficiency in their plant. Part of the geographical reason for the rise of the acid steel industry in Cleveland and South Wales—namely, the ease of import of foreign ores—had almost ceased to operate. There was a constant danger, owing to the submarine menace, of our supplies of rich foreign ores being cut off. Consequently a considerable portion of the steel industry had to be reconstructed in order to make use, by the basic process, of the abundant home supplies of phosphoric ore, and one of the greatest benefits which the War conferred on Great Britain was the extension and modernisation of our iron and steel plant which the exigencies of the times entailed. But the War-time expansion was out of balance with post-War requirements since the diversity factor in times of peace is greater than in times of war—it is better that the units of production should, in some cases, remain small because of the great variety of products required.

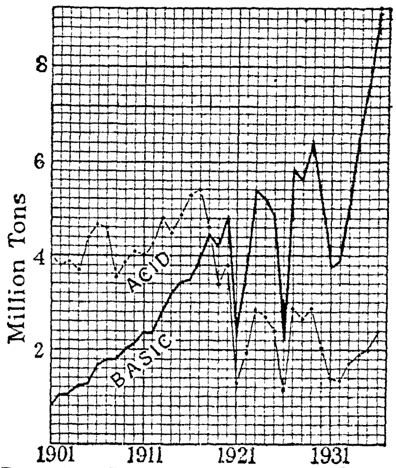


FIG. 185.—Recent production of acid and basic steels compared.
(1937, A, 2·5; B, 10·1; 1938, A, 1·9; B, 8·2.)

The post-1918 conditions of the iron and steel industry will be dealt with in Chapter XVIII.

The following table on p. 338 (adapted, with emendations, from "Survey of Metal Industries," p. 2) may assist the reader in his comprehension of the various processes and products of the iron and steel industry.[1]

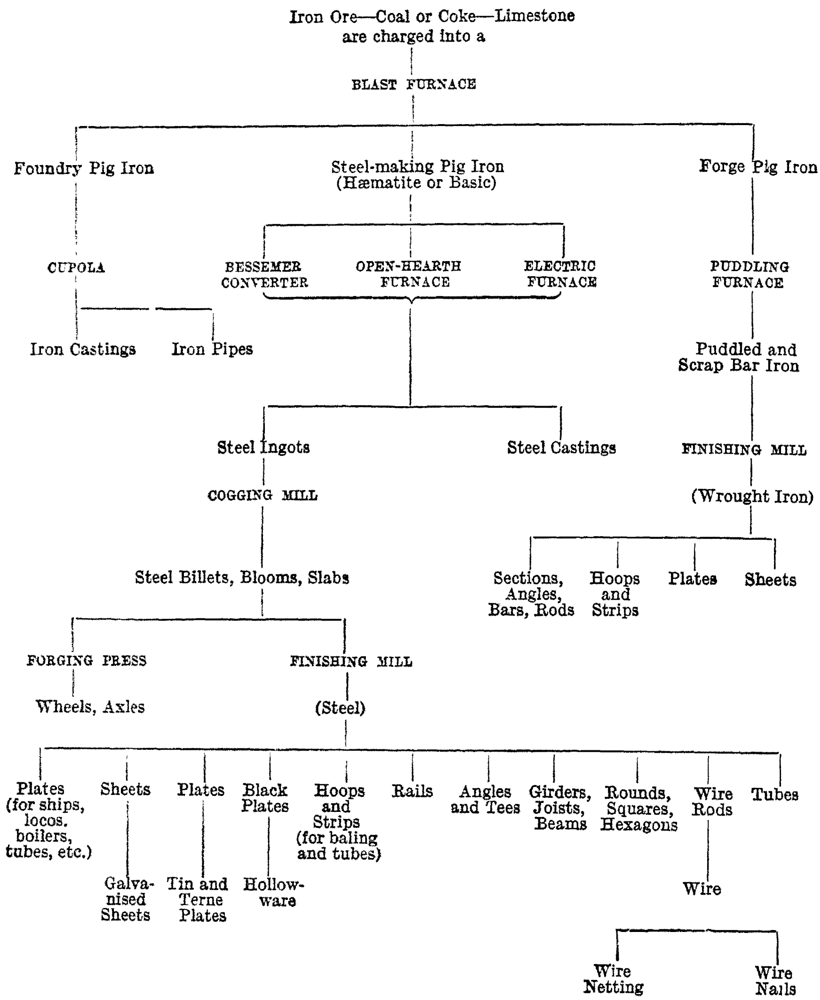
THE PRESENT CONDITIONS OF THE INDUSTRY

There are three major factors affecting the localisation of an iron and steel industry—the supply of ore, the supply of fuel, and the market for the produce.[2] One or more of these must be present

[1] See *Iron and Steel To-day,* J. Dearden (Oxford, 1939), for an excellent popular account of the principles and processes of the industry.

[2] Whilst a supply of limestone is normally essential to the industry, this raw material is never a localising factor, since limestones are so readily available in most districts where either iron ore or coal are found; *e.g.* Coal Measure ironstones are seldom far from thick Carboniferous or Magnesian Limestone deposits, and the Jurassic ironstones occur in a series, the principal members of which are frequently limestones of greater or less purity.

in order to give rise to such an industry. The earliest British iron industries in the Forest of Dean and the Weald were situated where ores of iron were found in close proximity to an assured charcoal supply from the forests. Similarly, the first iron industry based



on coal as a fuel became localised in Staffordshire and Salop, where both coal and iron were found in the same series of rocks. The industries of Cleveland and of the Furness district of Lancashire, however, were localised upon ore-producing regions, with the near-by Durham coke and the coastal situation for the export of the

produce as other favourable factors.[1] Modern transport facilities may render possible the rise of an iron and steel industry in an area devoid of both coal and iron ore—as, for example, the Ford ironworks at Dagenham, on Thames-side, obtaining foreign ore and Durham coal by sea, and having its own assured market in the adjacent motor works.

Raw Materials.—In order to examine the British iron and steel industry from the point of view of geographical control of development, we must first consider the raw material supplies. The question of fuel has already been dealt with (Chapter XV), and the supply of limestone can best be discussed when dealing with individual areas. It remains, then, to consider the iron ore. The ores of iron that occur in Britain may be grouped into four broad divisions. (See table on p. 348.)

1. *Hæmatite* (Fe_2O_3), including "kidney ore." This occurs in Cumberland and North-west Lancashire[2] in various irregular deposits in the Carboniferous Limestone which wraps round the western and southern sides of the Lake District dome. The iron is generally assumed to have been derived by solution from the red Triassic beds which formerly covered the area, and subsequent concentration in cavities in the jointed limestone—the concentration being frequently guided by faults which brought together beds of contrasted texture.

Two separate areas are important for the production of this type of ore, and the mode of occurrence in each of these is rather different. In West Cumberland, in the neighbourhood of Cleator, Egremont, and Beckermet occur numerous irregular masses of ore,

[1] The following figures, which are approximate and refer to the year 1931, compare the expenditure at a Derbyshire and a Northamptonshire ironworks:

	Derbyshire	Northamptonshire
Coke per ton	16*s.*	16*s.*
Freight on coke per ton	nil	7*s.*
Ore per ton	3*s.*	3*s.*
Freight on ore per ton	7*s.*	nil
Total	26*s.*	26*s.*

But for 1 ton of pig-iron, 3 tons of ore are necessary as against 25–30 cwt. of coke. The cost of material for 1 ton of pig-iron in each case (excluding limestone, which is locally available in both areas) is therefore about 50*s.* for Derbyshire, compared with about 42*s.* for Northamptonshire; and if we take account of the Government rebates on railway traffic (which amount to between 25 per cent. and 30 per cent. on coke, and 10 per cent. on ore) the position of Northamptonshire is still further improved. The Northamptonshire ironworks will, however, have to pay higher freight rates on their pig-iron than the Derbyshire works when sending it away to the foundries and steelworks centred on the coalfields.

[2] *Mem. Geol. Survey*, Special Reports on Mineral Resources. Vol. VIII. *Hæmatites of West Cumberland, Lancashire, and the Lake District*, 2nd edition, 1924. See also T. H. Bainbridge: "Iron Ore Mining in Cumbria," *Geography* XIX, 1934, 274–287.

sometimes disposed more or less vertically up against faults, sometimes more or less inter-bedded with the limestone and the sand-

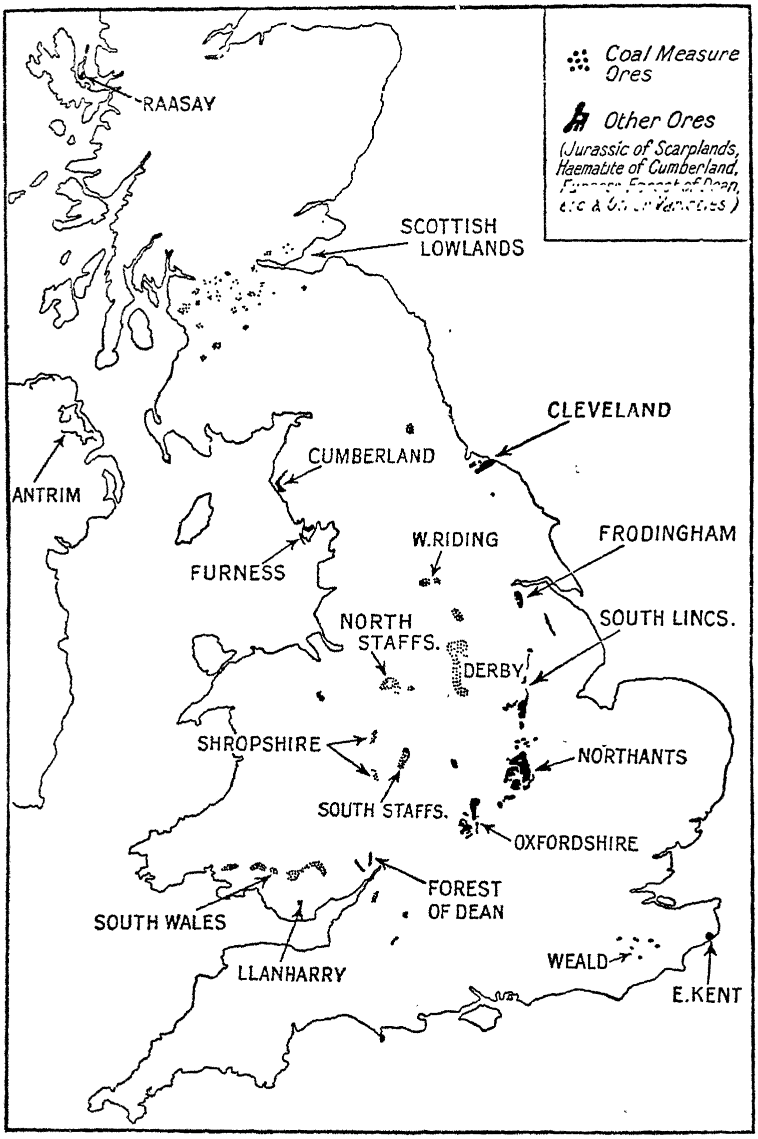


FIG. 186.—The iron ores of Britain.

stone and the shales which accompany it, and in other cases showing no form or structure at all. Further south, extending on either

side of the Duddon estuary from south-west Cumberland into the Furness district are a number of dish-like deposits, practically solid masses of ore occupying great hollows in the limestone. The largest of these, the famous Hodbarrow deposit, near Millom, contained originally over eight million cubic yards of almost solid ore. In both areas the deposits are within a few hundred feet of the surface, but they are covered by thick deposits of glacial drift, which conceals the "solid" geology and increases the difficulty of locating and working the ores.

The two areas were formerly of equal importance as ore raisers, but the greater ease of working the Furness deposits has led to their extinction more rapidly than is the case with the irregular veins and masses of western Cumberland, and whereas in the early 'eighties (the period of greatest production) each area was producing about $1\frac{1}{2}$ million tons per annum (see Fig. 187), the Furness area has declined to a mere 100,000 tons, whilst Cumberland is still producing $\frac{3}{4}$ million tons (see table on p. 348). The chief mining centres at the present time are Egremont, Beckermet, and Millom (Hodbarrow). This hæmatite is the richest ore produced in Britain, having an iron content of between 50 and 60 per cent. It is also important as being non-phosphoric.

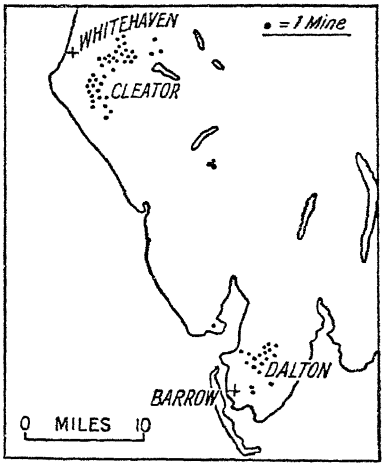


FIG. 187.—Map showing the iron mines of Cumberland and Furness in 1882.

The modern development of these ores dates from about 1825, and a great fillip was given to their extraction and export by the completion of the Furness Railway in 1846, and of the Whitehaven, Cleator, and Egremont line in 1857.[1]

2. *The Bedded Ores occurring in the Coal Measures.*[2]—These ores are of great historical interest since they were the foundation upon which British supremacy in the iron industry was built up during the hundred years 1750 to 1850. At the end of this period they still accounted for nine-tenths of the entire British output of ore, and production continued to increase in certain areas until

[1] In the late 'fifties close on 300,000 tons of ore were being exported annually—mostly to South Wales.

[2] Mem. Geol. Surv. Mineral Resources. Vol. XIII. *Pre-Carboniferous and Carboniferous bedded Ores of England and Wales*, 1920; also Vol. XI. *Iron Ores of Scotland*, 1920.

the 'seventies. Since then, however, the output has rapidly declined both relatively and absolutely, and at the present time the ores, except in one area, are almost insignificant. There are two distinct varieties of ore found in the Coal Measures, "clayband" and "blackband." Clayband ironstone consists of carbonate of iron mechanically mingled with earthy matter. It usually takes the form of thin seams, either continuous or nodular, varying from a few inches to several feet in thickness, interbedded with shales or less frequently with sandstones. It is noteworthy that the clayband ores are not evenly distributed throughout the Coal Measures, either stratigraphically or in area. The areas over which they were formerly of greatest importance are South Staffordshire, Shropshire, South Wales, Derbyshire, the West Riding of Yorkshire, and the Scottish Lowlands.[1] The blackband ores are carbonaceous ironstones, *i.e.* they contain coaly matter sufficient for calcining the ore without the addition of coal. They occur in even closer association with coal than the claybands. They are usually found on the top of coal seams and in Scotland some blackbands are actually found to pass laterally into coal. On the other hand, however, they usually occur in thinner seams than the claybands. Their value as ores of iron was not realised until 1801, and it was some time before they were extensively used in the iron industry. The only two coalfield areas in which they were discovered to be developed in quantity were North Staffordshire and Scotland. In Scotland they were especially valuable since they showed such an adaptability to the use of the hot blast (*vide supra*), a far greater reduction in fuel consumption being obtained when using blackband ores and the Scottish "splint" coal than with any other combination of ore and fuel.[2] In contrast with the hæmatite, the clayband and blackband ores are lean, containing only about 30 per cent. of metallic iron.

The decline in the output of Coal Measure ironstone has been due to two main causes. In the first place there is the actual exhaustion of many of the best seams, especially in those areas like Shropshire and South Staffordshire, which were earliest worked. But the ores are by no means wholly exhausted. According to the official estimate (Imp. Min. Res. Bur.) there are "actual" reserves of over 1,000 million tons, and a further "probable" reserve of 1,200 million tons. The second reason is thus the increasing difficulty and cost of working such thin seams of lean ore at depth (for an enormous amount of "waste" material has to be removed and brought to the surface before the bands and nodules of ore can be extracted). This cost has been rendered prohibitive by the

[1] It should be noted that iron ores, as well as coal, occur in the "Carboniferous Limestone" and "Millstone Grit" formations of Scotland, in addition to their development in the true Coal Measures. See chapter on Coal (p. 310).

[2] Owing to the amount of carbonaceous matter which they contain, the blackband ores are self-calcining and not far from being self-smelting.

cheapness with which equally good Jurassic ores, quarried or mined in thick bands at small depth, can be obtained.[1] The greater part of this huge reserve, then, will never be mined under present economic conditions, and in consequence the Coal Measure ores can no longer be said to exert any controlling influence over the distribution of the iron and steel industry. The only region producing appreciable quantities of Coal Measure ores to-day is North Staffordshire. Coal mines in other areas only raise the ore when they happen to strike a bed in close proximity to a coal seam; in other words, the ore is now only a by-product of coal mining.[2]

3. *The Bedded Ores of the Jurassic Rocks.*[3]—Although certain of these ores, as in Northamptonshire and Lincolnshire, were worked in Roman and medieval times, their value as ores of iron seems to have been completely forgotten for several centuries,[4] and they were hailed as new discoveries about 1850. Since that date they have, to an increasing extent, dominated the British iron and steel industry, until at the present time their output represents over 90 per cent. of the total ore raised in the British Isles. The ores occur at several different horizons in the Jurassic sequence. Several characteristics are common to them all and serve to distinguish them in a very marked way from the ores which we have previously considered. They are all lean ores, varying in their iron content from less than 22 to about 33 per cent.; they all occur in thick beds, generally about 10 feet thick, but ranging from a foot or two to over 30 feet, and in common with the whole Jurassic series they are tilted gently to the east or south-east without being greatly disturbed by folding or faulting. Furthermore, they are all either quite close to the surface so that they can be quarried, or are easily accessible by shallow mining. In all of them the iron is in the chemical form of chamosite (a silicate of iron) or siderite (carbonate of iron), and is an original constituent of the rock, though in most cases subsequent enrichment and oxidation has occurred through the action of atmospheric waters. It is worthy of note that the "minette" ores of Lorraine are of precisely the same character and occur on almost the same stratigraphical horizon as the Northampton Sands ores. Four important deposits may be distinguished.

(*a*) In north Lincolnshire, in the neighbourhood of Frodingham and Scunthorpe, certain beds in the Lower Lias formation are

[1] The average selling price of Coal Measure ironstone between 1925 and 1931 was just over 13*s*. per ton; the figure for the equally rich Northamptonshire stone was little more than 3*s*.

[2] Two mines in North Staffs produced 121,000 tons in 1938. The remaining 29,000 tons came from fifty-four mines, *i.e.* about 500 tons per mine per annum, but 16 mines in Scotland produced 17,500 tons; 21 mines in South Staffs produced only 6,000 tons.

[3] Mem. Geol. Surv. Mineral Resources. Vol. XII. *Bedded Ores of the Lias, Oolite and later formations in England*, 1920.

[4] One John Morton, writing in 1712, actually denies the existence of iron ore in Northamptonshire. ("Natural History of Northamptonshire," p. 549.)

ferruginous. This is the thickest of the Jurassic ironstones, between 20 and 30 feet being worked, and all the work is opencast, for, although the thickness of overburden may amount to 60 feet, it consists of soft clays and shales which can be removed mechanically. The ore is, however, very lean, averaging only 22 per cent. of iron; moreover it contains up to 25 per cent. of lime and an appreciable quantity of manganese—both qualities which have considerable effect upon the nature of the industry based on the ores. The Frodingham ore was first worked in 1859, and has steadily progressed in importance until it now represents over 20 per cent. of the total British output.

(*b*) The "Marlstone" bed of the Middle Lias yields iron in two quite distinct areas, the Cleveland Hills of Yorkshire and the scarplands from Lincolnshire to Oxfordshire. The marlstone is not always an iron ore. Between North Yorkshire and South Lincolnshire it is barren; a gap separates the South Lincolnshire field from the Leicestershire field, and this again is separated by a barren area from the Banbury ore-bearing district. In North Yorkshire the marlstone crops out on the northern flanks of the Cleveland Hills, dipping gently south-eastwards. Owing to the resistant nature of the overlying beds which form the Hills the ore bed quickly disappears underground. It was first quarried in the outliers of Eston and Upleatham only a few miles from the Tees estuary. Almost at once adit mining (*i.e.* tunnels driven into the hillside) became necessary, and subsequently vertical shafts have been sunk to depths of as much as 700 feet.[1] The ore bed deteriorates south-eastwards and becomes divided by shale partings which quickly reduce its thickness from the 10 feet which is worked on the north-western edge of the field. The total amount of ore which has been removed from this field is about 330 million tons, and the beds are approaching exhaustion. Production has declined from 6 million tons in 1913 to under 2 million tons in the years 1931–36—and if only this latter rate of production is maintained the ore will be exhausted in about 60 or 70 years.[2] But the cost and difficulty of mining is increasing and this, combined with the reduction of output, is having considerable effect upon the economy of the Teesmouth industry.

The other marlstone areas are all worked opencast. The iron in these ores is the result of concentration due to the atmospheric weathering of lean ferruginous mudstones, and consequently, as soon as the bed disappears beneath the cover of newer deposits, where it has been protected from such weathering, the iron content

[1] The deepest mine is North Skelton, 720 feet.

[2] In 1920 (*Iron Ores*, XII, 35) the Geological Survey, assuming a continuation of the pre-War output of 6 million tons, gave the field a life of 30 years. The reduced output will considerably prolong this period, and several more decades might be added if economic conditions should permit the working of the "probable" as well as the "actual" reserves.

diminishes so rapidly as to render the rock useless as an ore.[1] Consequently mining will probably never be necessary. The three separate fields are: (1) the Caythorpe district of South Lincolnshire (the smallest); (2) the Melton Mowbray ironstone ridge, around

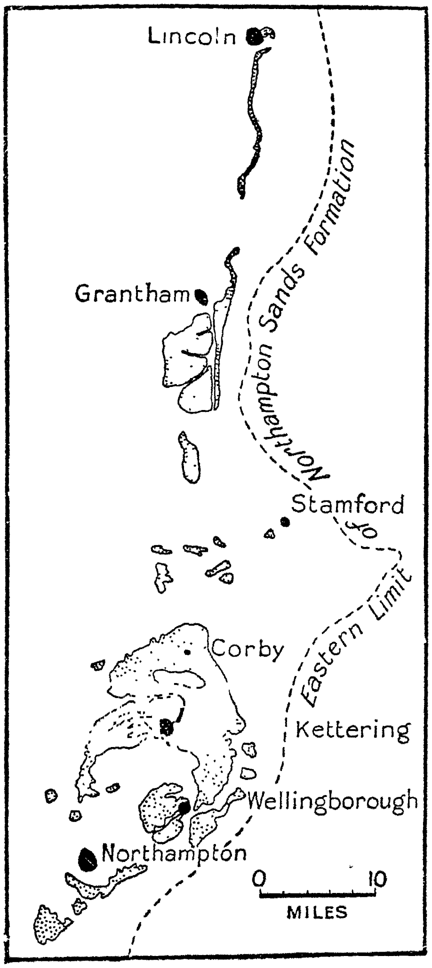


FIG. 188.—The Northampton Sands iron-ore field.
The dotted areas are workable ore.

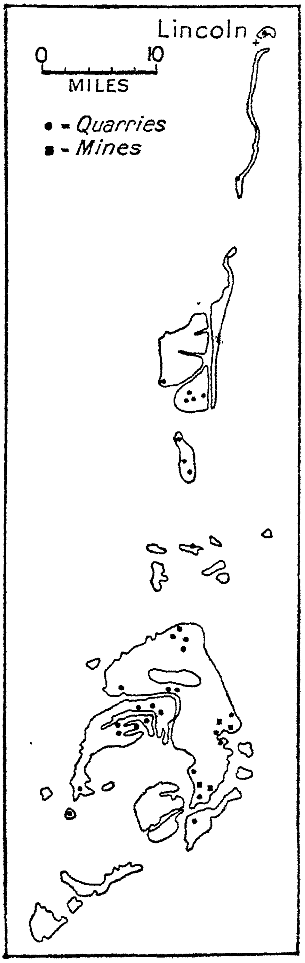


FIG. 189.—The Northampton Sands iron-ore field.
Quarries and mines, 1928.

Holwell and Eaton in Leicestershire (the most important); (3) the Banbury district on the borders of Oxfordshire and Northamptonshire. In each of these areas the ore bed varies from about 6 to 12 feet in thickness, but often much has been lost through denudation.

All the marlstone districts produce lean ores. The Cleveland

[1] *Iron Ores*, XII, 110.

ore contains on the average about 28 per cent. of iron, and the quarried ores of the scarplands about 25 per cent.

(c) That portion of the Inferior Oolite formation in Northamptonshire, Rutland, and South Lincolnshire, known as the "Northampton Sands," is, and will continue to be, one of the vital factors in the British iron industry.[1] It contains a bed of iron ore, generally between 6 and 12 feet in thickness, which is not only the richest of the Jurassic ores (iron content 33 per cent.) but also offers the most extensive reserve of ore of any of these fields. At the present rate of production (average 1931–36, 3·6 million tons per year) the ore will last for at least 500 years.[2] The field stretches, with slight interruptions due to deterioration and denudation, from Lincoln to Towcester and, unlike the marlstone of the neighbouring areas, the ore does not deteriorate eastwards under cover. Whilst the greater part is still obtained by quarrying, there is therefore abundant prospect of the increase of shallow adit mining for several miles east of the outcrop. The Northampton Sands ore is siliceous, a fact which has had considerable influence upon its employment.

In all the Jurassic ore fields, except Cleveland, the railway facilities have had a great bearing upon the working of the ore, and as the vales at the foot of the Marlstone and Inferior Oolite scarps provided excellent railway routes very little additional mineral line construction has been necessary.[3] In Cleveland the more dissected nature of the country led to the building of a large number of special mineral lines and connections with the existing tortuous branches of the L.N.E.R. (see Fig. 192).

Again, except for Middlesbrough, Frodingham, and more recently Corby, the working of the Jurassic ore fields has not given rise to any marked change in the distribution of population. The reason is to be found in (a) the scattered nature of the quarries, and in (b) the geological conditions which permit the use of mechanical appliances and consequently a small man-power.

4. *Miscellaneous Ore Deposits.*—Although of very small importance at the present time (since they provide only just over 1 per cent. of the total output), certain other occurrences of iron ore have been important at various periods in the past and deserve passing notice.

In the Carboniferous Limestone of the Forest of Dean limonite (*i.e.* oxidised hæmatite) ($Fe_2O_3+3H_2O$), occurring in the same irregular fashion as the Cumberland hæmatites, has been mined from Roman times, and it gave rise to an extensive iron industry

[1] S. H. Beaver, "The Iron Industry of Northamptonshire, Rutland and South Lincolnshire," *Geography*, XVIII, 1933, pp. 102–117.

[2] In 1920 (*Iron Ores*, XII, 159) the Geological Survey estimated that an annual production of 3 million tons could be maintained for 760 years; subsequent investigation, however, has somewhat reduced the size of the workable field, and the output, largely owing to the developments at Corby, has expanded considerably (1937, 5·8 mn. tons; 1938, 5·2 mn. tons).

[3] The most important mineral line is the Stainby and High Dyke branch of the L.N.E.R. which carries annually over half a million tons of Northampton Sands ore from South Lincolnshire.

during the charcoal smelting period. Production declined rapidly after 1880 and has now practically ceased. A similar deposit in the same formation at Llanharry (Glamorgan) is the only one of the "other occurrences" which is still worked to any extent [1]; whilst a further deposit of the same nature, no longer worked, occurs in western Durham. Numerous small vein and bedded deposits of limonite, hæmatite, and magnetite have from time to time been worked in the Devonian rocks and in the granites of Devon and Cornwall.[2] They were of greatest importance in the 'sixties and 'seventies of last century, but were quickly worked out, and production from either county never exceeded 50,000 tons in any one year. The ore in the Upper Lias of Raasay, Scotland, was worked for a time, especially during the War, but its remoteness and low iron content (25 per cent.) have rendered the cost prohibitive. The deposit of magnetic ore occurring in the Inferior Oolite of Rosedale, Yorks, has long since been worked out. The Corallian beds of Westbury (Wilts.) contain an iron ore which formerly fed the furnace there. It is not now worked as an ore, but is quarried as an oxide for use in gas purification. The concealed Corallian rocks of the East Kent coalfield have also been found to contain a valuable ore. A bed of ironstone about 16 feet thick, at a depth of 650 feet, has been proved in the neighbourhood of Dover over an area of some six square miles. It is estimated to hold a reserve of 100 million tons [3] which could be mined from the existing coal shafts; and the bulk of it has been acquired by Dorman, Long & Co., the Middlesbrough smelters, who are also working the coal. Certain bodies of bedded ore occurring in the Cretaceous rocks have also been of importance in the past. Most noticeable, of course, are the ironstones in the Wealden rocks of Sussex and Kent, which were for so long the chief sources of British iron. Deposits in the Lower Cretaceous at Claxby (Lincs) and Seend (Wilts.) have been worked in a small way, and at Seend furnaces were actually erected, but neither deposit was very rich, and the workings have been extinct for many years.[4]

Inter-bedded with the Tertiary basalts of the Antrim plateau in north-eastern Ireland are deposits of aluminous iron ore, which were worked for several decades towards the end of last century and the beginning of the present.[5] The ores are no longer worked, and were mined chiefly for export to Cumberland where they were employed as an iron-bearing flux for the siliceous hæmatites of that area.

[1] *Mem. Geol. Surv., Iron Ores,* Vol. X: "The Hæmatites of the Forest of Dean and South Wales," 1919.

[2] *Ibid.,* Vol. XIII.

[3] *Mem. Geol. Surv., Iron Ores,* Vol. XII, 223–226.

[4] Mining at Holton-le-Moor, near Claxby, was revived by a Scunthorpe firm in 1934. In 1938 the mine employed nearly 150 men.

[5] Kendall, *op. cit.,* pp. 255–262.

IRON ORE PRODUCTION. (Thousand Tons)

Formation	1913	Average 1921–25	Average 1926–30	Average iron content, per cent.	Average selling price, 1927–30		1933	1934	1935	1936	1937	1938	Reserves[2] (million tons)	
					s.	d.							Actual	Probable further reserves
HÆMATITE :														
Cumberland	1,361	713	957	53	17	4	530	711	708	750	737	679	40	72
Lancashire	406	161	130	54	18	5	103	102	132	130	120	116	5	18
Total	1,767	874	1,087	—	—		633	813	840	880	857	795	45	90
JURASSIC :														
Lower Lias	*	1,728	2,204	22	2	7	1,934	2,473	2,436	2,962	3,047	2,505	260	238
Middle Lias, Cleveland . .	5,941	1,754	2,124	28	6	1	1,013	1,642	1,640	1,848	2,037	1,514	190	151
Middle Lias, other areas . .	*	1,255	1,449	25	2	6	958	1,419	1,355	1,679	2,001	1,463	102	158
Inferior Oolite	*	2,405	2,971	32	3	1	2,724	3,949	4,311	4,927	5,834	5,244	660	1,630
Total	12,572	7,144	8,748	—		—	6,628	9,483	9,742	11,417	12,919	10,726	1,212	2,177
COAL MEASURES :														
N. Staffs.	*	267	268	33	12	8	80	120	145	149	141	121	364	940
S. Staffs.	*	14	10	30	18	10	6	6	6	7	8	6	11	63
Scotland	591	78	20	30	9	0	3	11	14	16	22	17	8	77
Other areas	*	20	13	33	18	0	6	5	2	2	7	6	663[3]	178
Total	1,542	379	311	—	—		95	143	167	174	178	150	1,049	1,247
Other occurrences . . .	116[1]	87	137	—	—		106	148	146	230	260	150	—	15
TOTAL	15,997[1]	8,483	10,283	—	—		7,462	10,587	10,895	12,701	14,215	11,859	2,306	3,530

* Not available, as figures given by counties only, not by formations.
[2] Imperial Mineral Resources Bureau, 1922.
[1] Includes 60,000 tons from Antrim, Ireland.
[3] Chiefly Derby and Notts.

IMPORT AND INTERNAL MOVEMENT OF IRON ORE

Despite the extensive reorganisation of the British iron and steel industry which was conducted during 1914–18, when our capacity for producing basic steel from the home Jurassic ores was considerably enhanced, our imports of rich foreign ores have not proportionately diminished. This import began to be apparent in the 'seventies when the demand for steel made by the acid processes became so great that Cumberland and Furness, even though their output rose to over 3 million tons yearly, could not supply sufficient ore to feed the furnaces. By 1900 the amount had risen to 30 per cent. of the total quantity used, at which figure it has remained almost stationary ever since, for the increased use of the home phosphoric ores has balanced the decrease in the supply of West Coast hæmatite. Our earliest imports came almost entirely from Spain, which possessed, in the province of Vizcaya, huge reserves of rich hæmatite ore, non-phosphoric and yielding 50–60 per cent. of iron. During the 'eighties, in fact, the greater part of the shipment from Bilbao, amounting to between 3 and 4 million tons per annum, was destined for British ports. Swedish ores, whilst being very rich in iron (mostly 60 to 70 per cent. and some deposits containing even over 90 per cent.) are mostly phosphoric, and this fact, combined with the lack of transport facilities, prevented any considerable import thereof before the discovery of the basic process. The first Swedish ores to arrive in this country came from central Sweden (the Grängesberg and Dannemora areas). The colossal deposits of Northern Sweden at Gällivare and Kiirunavaare were not available until railways were built to the coasts. Lulea began to ship ore in 1887, and the Norwegian port of Narvik began exporting Swedish ore in 1903—since when our Swedish imports have been maintained at a fairly constant level. In more recent years (since 1900) considerable quantities of rich non-phosphoric hæmatite have been received from Algeria and Tunisia, where there are extensive deposits of ore yielding 50–60 per cent. of iron.

On an average some 4 to 5 million tons of ore are annually imported into Britain. Over one-third of this total now comes from North Africa. Spain has fallen from its pre-War dominant position, sending only about a quarter of the total. The Scandinavian countries send about the same amount. Most of this comes from Sweden [1] (though about half of the Swedish export is received *via* Narvik), but Norway is sending increasing quantities of concentrates and briquetted ores, which are obtained chiefly from igneous rocks by magnetic concentration, an operation which is of course favoured by an abundance of hydro-electric power. France sends moderately rich hæmatite (about 50 per cent. iron) from

[1] A large proportion produced with the help of British capital.

TABLE OF IRON ORE IMPORTS [1]

(Thousand Tons)

Country	1913	Average 1922–25	Average 1926–30	1931	1932	1933	1934	1935	1936
Spain . . .	4,525	2,175	1,996	890	808	876	1,182	1,129	1,189
Norway and Sweden [2] .	854	863	794	446	336	606	1,010	1,191	1,676
Algeria . .	759	921	806	369	307	621	1,003	956	1,364
Tunis . . .	279	275	317	189	176	228	433	429	601
France . .	327	360	155	77	25	72	91	107	233
Spanish North Africa . .	—	78	80	20	35	100	223	268	166
Other countries	486	154	105	115	80	197	371	423	686[3]
Total . .	7,230	4,826	4,253	2,108	1,767	2,699	4,313	4,503	5,915

[1] Figures from Annual Statistics of National Federation of Iron and Steel Manufacturers (since 1934, British Iron and Steel Federation). 1937, 6,953; 1938, 5,104.

[2] Norway and Sweden have been added together, since the Swedish ore, which comes *via* Narvik, is represented in the British trade statistics as of Norwegian origin. An examination of the official Swedish and Norwegian statistics for the year 1929, however, showed that Sweden actually exported 1,075,000 tons to Britain (cf. the official British figure of 724,000 tons), whilst Norway exported to Britain 158,000 tons (cf. the official British figure of 513,000 tons).

[3] Includes 136,000 tons from Newfoundland and 379,000 tons from Sierra Leone.

Normandy (*via* Caen). The latest countries to send ore to Britain are Sierra Leone (1933), where a Scottish firm has been largely responsible for opening up a new field, and Brazil (1936), whilst there has been a revival in the import from Newfoundland.

This extensive import of iron ore is by no means evenly distributed amongst the British iron-making districts (see below). Only those areas which have a coastal situation are able to make use of foreign ores,[1] the cost of trans-shipment and rail transport prohibiting their use in the inland furnaces. In many cases (*e.g.* Middlesbrough, Port Talbot, Barrow) the ore is unloaded direct from the ship's hold on to the store heaps of the ironworks, and the return freight of coal and finished iron and steel products which is frequently available renders such importation cheap. Middlesbrough, with over 50 blast furnaces along the Tees waterfront, takes no less than a third of all the ore imported, despite the proximity of the Marlstone ore in the Cleveland Hills. This statement reflects very well (*a*) the increasing cost and failing supplies of Cleveland ore, and (*b*) the momentum of over 60 years' constant association with the import of rich ores for acid steel making. The South Wales ports import chiefly from Spain and Normandy, the coastal

[1] Some of the big combines, like the Consett Iron Co. and Guest-Keen-Baldwins, control certain foreign mines, *e.g.* Orconera (Spain). Baird's, of Coatbridge, have subsidiary companies working ore in Spain and in Sierra Leone.

iron and steel works of Cumberland and Furness, and of Central Scotland also import foreign ore, whilst Liverpool and Manchester receive ore for the South Lancashire plants and Grimsby imports for some of the Yorkshire furnaces.

TABLE OF PORTS IMPORTING IRON ORE, 1929 AND 1935.
(Thousand Tons)

	1929	1935		1929	1935
Middlesbrough . . .	1,965	1,465	Ardrossan	208	117
Cardiff	648	249	Liverpool	169	222
Newcastle	499	348	Barrow	125	132
Newport	473	6[1]	Workington	117	209
Glasgow	447	285	Manchester	103	157
Grimsby and Immingham	278	302	Sunderland	53	40
Port Talbot . . .	263	428	Hartlepool	23	—
Grangemouth . . .	247	241	Total	5,623	4,503

[1] This is due to the closing of the Ebbw Vale works in 1929.

An extensive system of internal ore transport also exists in Britain, and it has an interesting geographical background. We have already seen that the presence of iron ores and coal in the same measures gave rise to iron industries in Staffordshire, Yorkshire (West Riding), Nottinghamshire, and Derby, and South Wales. The diminution in the supply of Coal Measure ores has, however, left these areas without their local raw material, which must in consequence be drawn from further afield. The Jurassic scarplands (excluding Cleveland), on the other hand, have huge ore supplies and no coal. Consequently, although furnaces exist in Northamptonshire, near Melton Mowbray (Leicestershire) and at Frodingham, the greater proportion of the Jurassic ore is "exported" to these old-established regions. Most of the Frodingham ore is used in the local furnaces, but a considerable proportion of the Marlstone and Northampton Sands ores

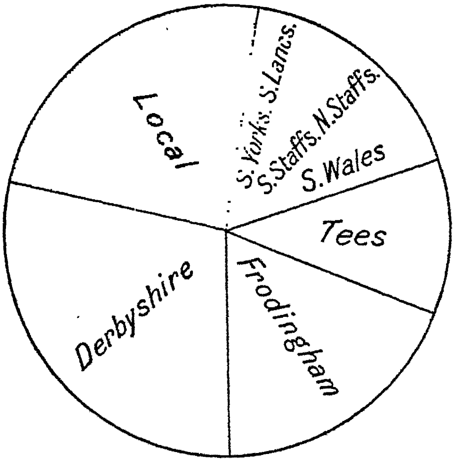


FIG. 190.—Diagram showing destination of Northampton Sands iron ore (1929).
(Total production 1929, 3·88 million tons.)

goes into the furnaces of the Midlands. An interesting transference of ore also takes place as a result of the calcareous nature of the Frodingham ore, which is so limy that it cannot be used alone in the furnace, but requires a siliceous complement—which is supplied by the ore from the Northampton Sands of Lincolnshire and Northamptonshire.[1] The decline in the Cleveland production is further reflected in the increasing amount of Northamptonshire and Rutland ore which is being sent to the Teesmouth furnaces. As a comment upon the facts enunciated above, Fig. 190 shows the destination of the Northampton Sands ore.

Attention must finally be drawn to the import of manganese ore. This ore is employed, to the extent of a little over 1 cwt. for every ton of pig-iron made, in blast furnaces which are smelting the Jurassic ores with a view to the manufacture of basic steel. It is also employed as ferro-manganese in the production of certain fine varieties of steel. As might be expected, Middlesbrough takes the greatest quantity, whilst Birkenhead imports for the furnaces and steelworks of the Midlands. Most of the manganese ore comes from India.[2]

THE SMELTING AND STEEL-MAKING DISTRICTS

The British iron and steel industry affords numerous examples of "geographical momentum"—the continuance of a human activity in a region, after some or all of the causes which gave rise to that activity have ceased to operate. By reason of the size and cost of its plant the manufacture of iron and steel tends to be one of the most inert of industries, and, rather than abandon their works and move to a better site, manufacturers will go to great lengths to improve their efficiency, or their transport, or will specialise in certain types of produce. Slowly, but surely, however, economic factors in the shape of competition from better situated producers will operate. If the industry originally set up has resulted in the accumulation of a large population in its neighbourhood, it is highly probable that production of some kind will continue by reason of the skilled labour there present; if the original industry was but small it must inevitably die out. Since our industry was built

[1] Cf. the interchange, in Lorraine, of the limy ores of the Briey plateau and the siliceous ores of the Longwy and Nancy regions.

[2] Import of manganese ore, 1935 (thousand tons):

Middlesbrough	83
Liverpool-Birkenhead	49
Workington	50
Manchester	14
Total	228 (of which 172 from India and 30 from Gold Coast).

up mainly upon Coal Measure ores, which are now scarcely worked at all, it follows that one of the main advantages formerly possessed by the iron industries of the coalfields has been lost. We must examine the producing areas individually in order to see how this change in location of the ore supplies has affected them.

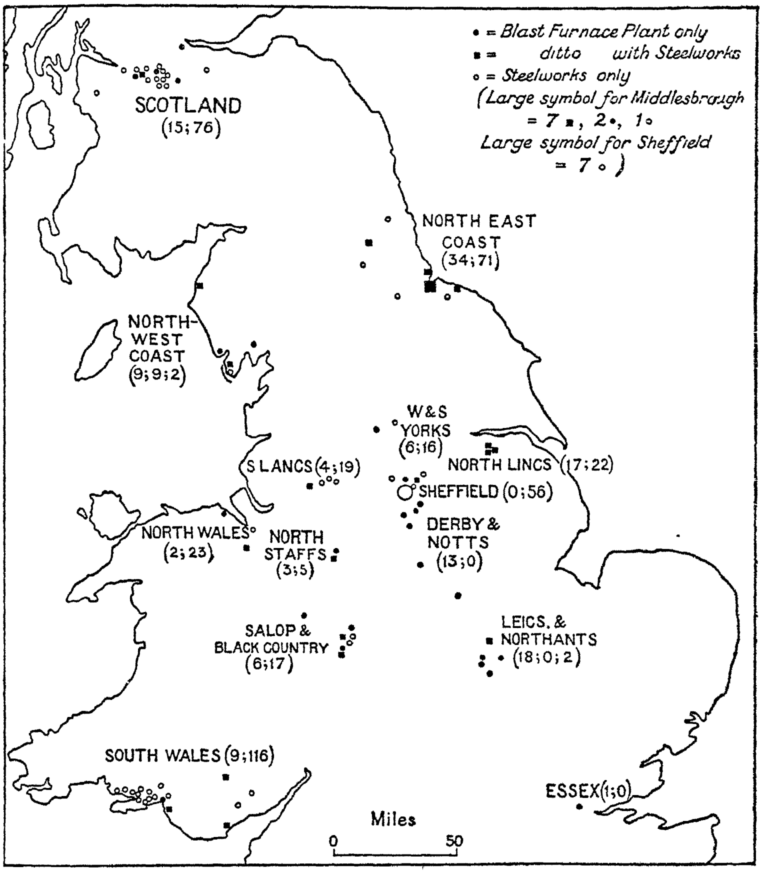


FIG. 191.—The British Iron and Steel Industry, 1937.

Onl[illegible] idle works are obsolete (cf. p. 368). The first figure in [illegible] ctive blast furnaces; the second of open-hearth steel [illegible] of Bessemer converters. The number of blast-furnace [illegible] named in June, 1937, was as follows (with 1921 figures in brackets for comparison): Scotland 53 (102); N.-E. Coast 56 (114); N.-W. Coast 18 (47); S. Lancs 4 (13); W. and S. Yorks 8 (38); N. Lincs 17 (23); Derby and Notts 13 (19); Leics and Northants 21 (23); N. Wales 3 (3); N. Staffs 6 (15); Salop and Black Country 23 (43); S. Wales 12 (33); Essex 1 (0). Total 235 (486).

(1) *Scotland.*[1]—All the Scottish smelting works were established between 1760 and 1860. Their location is thus "rather an interesting relic of quite another age."[2] The first, apart from a few

[1] See H. Hamilton, *The Industrial Revolution in Scotland*, Chapters VII and VIII, for an excellent account of the development of the Scottish iron industry.

[2] P. R. Crowe, "The Scottish Coalfields," *Scot. Geog. Mag.*, XLV, 1929, 321–337.

TABLE OF PIG-IRON PRODUCTION (BY DISTRICTS)
(Thousand Tons)

District	1913	Average 1921–1925	Average 1926–1930	1931	1932	1933	1934	1935	1936
Derby, Leics., Notts., Northants. . .	1,166	839	937	979	872	750	1,104	1,441	1,699
Lancs. and Yorks. .	503	466	388	205	235	222	388	398	460
Lincolnshire . . .	450	480	653	412	463	609	850	862	1,023
N.-E. Coast . . .	3,869	1,766	1,853	1,137	878	1,063	1,684	1,721	2,117
Scotland	1,369	503	500	154	144	220	392	413	471
Staffs., Salop, Worcs., Warwick . . .	851	404	370	202	282	307	385	405	434
S. Wales and Monmouth	889	636	669	280	354	451	492	513	751
N.-W. Coast . . .	1,163	613	656	404	346	513	674	673	767
Total . . .	10,260	5,706	6,026	3,773	3,574	4,136	5,969	6,424	7,721

TABLE OF STEEL PRODUCTION (INGOTS AND CASTINGS) (BY DISTRICTS)
(Thousand Tons)

District	1913	Average 1921–1925	Average 1926–1930	1931	1932	1933	1934	1935	1936
Derby, Northants., Notts., Lancs., Yorks. (excluding Sheffield), N. Wales	512	751	699	363	562	632	800	1,170	1,379
Lincolnshire . . .	241	367	531	392	444	703	959	1,086	1,178
N.-E. Coast . . .	2,031	1,357	1,736	1,142	1,001	1,317	1,815	2,050	2,504
Scotland	1,421	984	1,244	676	553	799	1,220	1,329	1,637
Staffs., Salop, Warwick, Worcs. . .	365	402	458	419	439	535	634	641	699
S. Wales and Monmouth	1,807	1,832	1,766	1,274	1,347	1,770	1,846	1,883	2,422
Sheffield	879	878	1,017	776	767	1,000	1,254	1,398	1,607
N.-W. Coast . . .	398	158	183	161	148	268	321	301	359
Total . . .	7,664	6,730	7,633	5,203	5,261	7,024	8,850	9,859	11,785

Total pig-iron production, 1937, 8,493; 1938, 6,761; total steel production, 1937, 12,984; 1938, 10,398.

charcoal furnaces erected on the west coast to use local timber and Lancashire hæmatite, was established by a Sheffield ironmaster at Carron, near Falkirk, in 1760, on a site within a few miles of the coast, where a good water supply was available, and close to clay-band ore and coal reserves. The works quickly became one of the largest and most famous in Europe. Progress generally was particularly marked, however, after Neilson in 1828 rendered the blackband ores more efficiently usable by means of the hot blast. The output, only 9,000 tons in 1806, rose to 210,000 tons in 1840,

and in the 'fifties, with over 150 furnaces available, Scotland was producing a quarter of the entire British output of pig-iron. After 1880 the production of blackband ores began rapidly to decline, and the ironworks, finding their ore supplies partly cut off, were obliged to import extensively from abroad. By distribution the smelting works fell into two main groups. The central group, clustered on the Lanarkshire coalfield, had its chief centres at Coatbridge, Airdrie, Motherwell, Wishaw, and Glasgow. Here the Monkland Canal and the Clyde, and later the railways, provided suitable means of transport for the bulky iron products, whilst the local "splint" coals [1] and the blackband ores were the basis of this industry (cf. Fig. 172 and Fig. 186). The North Ayrshire group was centred on Irvine and Kilbirnie, with outlying plants at Lugar and Muirkirk; it had the same basis of ore and fuel.

The prosperity of the Scottish ironworks was seriously undermined by the falling off in the local ore supply, and the situation was aggravated by the approaching exhaustion of the "splint" coals, which were used raw in the furnaces. These circumstances, together with the periods of depression which have characterised the post-1918 years, have been largely responsible for almost completely changing the aspect of the Scottish iron-smelting industry, by weeding out those works whose equipment or situation rendered them uneconomic. Pig-iron production is now concentrated on a mere handful of modernised plants, the chief of which are situated at Glasgow and Coatbridge. Of nearly 90 furnaces which existed in 1930 only about 50 remain—but not more than 15 of these can be considered as effective producing units; several complete works have been demolished and others await the same fate. This concentration on a few large plants has been accompanied and aided by the production of coke from Scottish coals, a process which was made possible by war-time and post-War research. New large furnaces, comparable with those in other parts of Britain, have been erected to use foreign ore and Scottish coke, and the largest works in Glasgow and Coatbridge each possesses its own coke ovens. Thus the small furnace producing foundry iron from local raw materials is no longer characteristic of the Scottish iron industry. Even the Carron works now imports ore *via* Grangemouth.

The steel industry is located for the most part in the neighbourhood of Coatbridge, Motherwell, Wishaw and Glasgow. It grew up apart from the blast furnaces, depending originally on imported hæmatite pig-iron, and in consequence the economies to be reaped

[1] The "Splint" coal, one of the most constant of the Lanarkshire seams, is of a hard splinty character specially valuable for furnace purposes. "It comes from the pit in big hard blocks which do not readily break up in the furnace under the weight of the overlying material, and the draught is thus kept open." (*Mem. Geol. Surv.*, "Economic Geology of the Central Coalfield of Scotland." Area V, 1926, 73.)

from the transfer of hot metal from blast furnace to steel furnace were not obtainable. Only recently (1936) has a famous Glasgow works linked up blast furnaces and steelworks into one great producing unit. During and after 1914–18 much of the plant was adapted for the production of basic steel, and about three-quarters of the output is now of the basic variety. Much of it, together with large quantities of imported semi-finished steel, goes into the local shipbuilding and engineering industries (see Chapter XVIII).

In addition to pig-iron and steel production, Scotland still has a small wrought-iron industry, centred on Coatbridge.

(2) *Teesmouth.*[1]—The advantages of Teesmouth for the setting up of iron and steel industries were unique. An abundant supply of ore in the Cleveland Hills, less than five miles away from tide water at first, and still well within 20 miles of Middlesbrough; ample

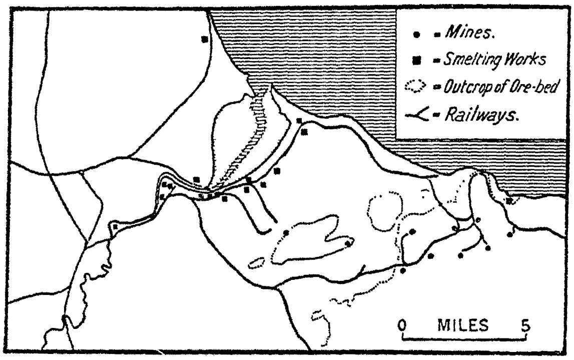


FIG. 192.—Map illustrating the Teesmouth iron industry.

supplies of the finest coking coal in the kingdom from south-west Durham, only 25 miles away and available by existing railways; limestone in abundance from the Carboniferous Limestone and Permian formations in Weardale; and a seaboard situation favourable, with the improvement of the estuary, for the export of the bulky products. It is little wonder that within 25 years of the commencement of the industry Teesmouth was producing $1\frac{3}{4}$ million tons of pig-iron, or close on 30 per cent. of the total British output. Moreover, after the introduction of the acid steel processes the coastal situation favoured the import of rich Spanish ores, which were rendered cheaper by the availability of a return cargo of coal from the adjacent coalfield, whilst the abundance of flat land alongside the estuary allowed ample room for the expansion of the works. All these advantages enabled Teesmouth to build

[1] See Ll. Rodwell Jones: *North England*, 40–54; Frey: "Iron and Steel Industry of the Middlesbrough District," *Econ. Geog.*, 1929; Appleton: "Iron and Steel Industry of the Cleveland District," *Econ. Geog.*, 1929.

up the greatest iron and steel industry in the whole of Britain. The serious depletion of the local ores, however, combined with the stimulus which was given to the industry during 1914–18, is bringing about changes in the nature of the industry. The pig-iron output is less than 40 per cent. of the 1913 total (see table on p. 354), and less than a third of it is now made from Cleveland ore. Spain, Algeria, and Sweden supply rich ores from abroad ; Northamptonshire and Rutland send over 300,000 tons per annum of lean ores and Cumberland sends a little hæmatite. Whilst the bulk of the pig-iron is converted into basic steel, large quantities are sent all over the country for foundry purposes.[1] Both pig-iron and steel are exported to Scotland and other coastal centres of the industry, and when prices are favourable, to the Continent. Much of the hæmatite pig-iron and steel made is sent to Sheffield for working up into the finer types of steel products. A large proportion of the steel production is absorbed by the local engineering and shipbuilding industries. The war-time expansion of the steel industry resulted in a vast improvement of the existing Teesmouth steelworks plant and the erection of a new works at Redcar. Subsequently foreign competition has resulted in renewed efforts to modernise the plant and to reduce working costs. As a result huge combines have been formed, bringing under a single control the coke and ore supplies, the furnaces and the steelworks, and even including the engineering industry and the marketing of the produce. An excellent example is furnished by Dorman Long, which unites Dorman, Long & Co., Bell Bros., North-Eastern Steel Co., Bolckow, Vaughan & Co., and other smaller establishments, and controls about a fifth of the country's output of iron and steel. The industry has been "rationalised" and inefficient plant eliminated. For example, Port Clarence works (opposite Middlesbrough), with 11 blast furnaces, closed down in 1930 and is not likely to work again.

The chief works in the north-east coast area away from the Tees are at West Hartlepool, just north of the estuary, and at Consett.[2] These outlying centres are supported entirely by foreign ore imported *via* Newcastle or Hartlepool.

(3) *The West Coast.*—The geographical bases of the iron and steel industry in West Cumberland and Furness were simple. Large supplies of rich hæmatite ore occurred within a few miles of the coast ; the ore was obtained from the Carboniferous Limestone, which could be used as a flux ; and the Durham coke lay not far away (by rail) across the Pennines (for only in comparatively recent years has the local Cumberland coal been available for coking purposes). Almost

[1] But Cleveland has given place to Northamptonshire as the chief producer of foundry iron. In 1936–37 only 2 out of 31 furnaces on Tees-side were producing foundry iron ; in Northamptonshire 7 out of 10.

[2] The location of the Consett works depended on the existence of a limited amount of clayband ironstone in the Coal Measures of the immediate vicinity.

without exception, then, the works are located on, or quite close to, the sea-shore, and consequently, owing to the absence of a large industrial market in the vicinity, it is the export trade in pig-iron which has been chiefly developed, the exports being to Sheffield, coastwise to Belfast, South Wales, and Scotland, and abroad. The first works (apart from the ancient charcoal furnaces [1]) were erected in 1841, but the greatest development came after the introduction

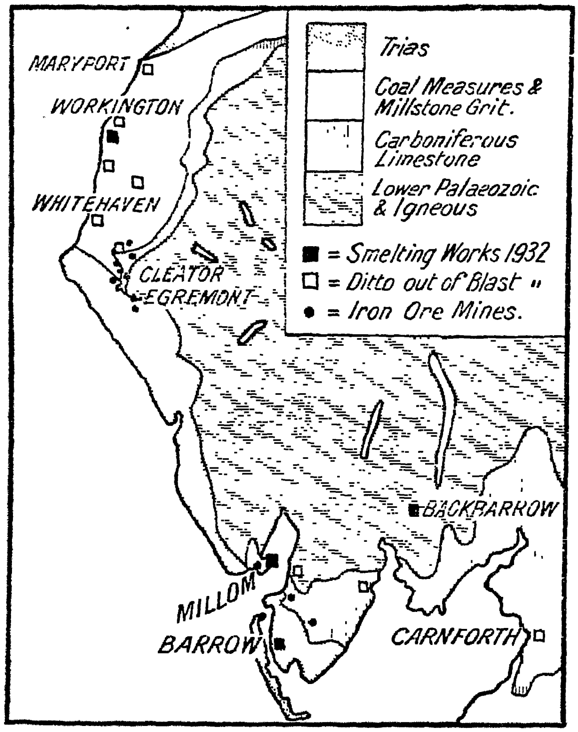


FIG. 193.—Map illustrating the West Coast iron industry.
Almost all the works marked as inactive in 1932 have since been demolished.

of Bessemer steel, and nine new works made their appearance in as many years, between 1870 and 1879. Much of the steel production is absorbed in the engineering and shipbuilding industries which have grown up at Barrow and Workington. The production of both pig-iron and steel has declined since 1918 owing to the decrease in the output of the local hæmatite mines, and foreign ore (mostly Spanish) [2] is being imported.

[1] The ancient Backbarrow works, founded in 1711, continued (in a modernised condition) to make charcoal iron well into the present century; with the virtual extinction of the local charcoal-burning industry it then turned to the use of coke.

[2] Spanish ores are preferred by reason of their high manganese content. The Millom & Askam Co. owns the Alquife mines in Spain (cf. p. 350, n.).

(4) *South Wales.*[1]—South Wales illustrates admirably the changes that have been brought about in the location of the iron and steel industry owing to changes in geographical values. The earliest working after the introduction of coke smelting grew up in the north-eastern part of the coalfield, around Ebbw Vale and Merthyr Tydfil. Here the clayband ores were richest and the gentle dip of the Coal Measures permitted the easy extraction of coal from quarries or adit mines. The setting up of the industry in this inland situation necessitated the growth of improved methods of transport, and the construction of tram-roads and canals to the coast further stimulated the iron trade and encouraged the development of docks at Newport and Cardiff for exporting coal

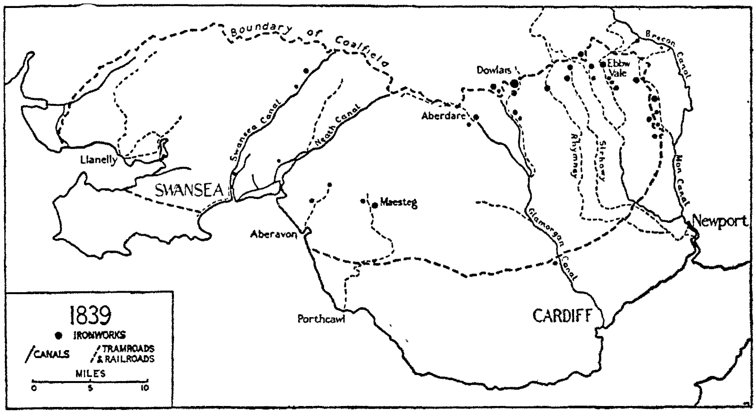


FIG. 194.—South Wales iron smelting works, canals and chief tramroads, 1839.

and iron. The introduction of the acid steel industry in the 'sixties, with its accompanying need for non-phosphoric ore, commenced slowly but surely to undermine the basis upon which the existing iron industry had been built. Interest now centred on the import of rich hæmatite from Spain and elsewhere (for the output of the Llanharry mines was quite inadequate for the needs of the growing industry). At first the momentum of the north-eastern region sufficed to attract the steel industry to that area, but gradually the advantages to be obtained by coastal sites where ore import was cheaper and easier began to outweigh this factor. One by one the early ironworks have been abandoned, only the largest of them surviving to bear witness to a decayed industry. Pig-iron production has migrated coastwards, and since about 1880 new steelworks have been set up close to tide water in the neighbourhood of

[1] See Rider and Trueman: *South Wales*, Chapter IX; also *Industrial Survey of South Wales* (Board of Trade, 1932).

Llanelly, the Loughor estuary (Bynea, Gorseinon, and Gowerton), Swansea, Briton Ferry, Port Talbot, and Cardiff, the marked concentration on the western region being partly due to the requirements of the tin-plate industry (see Chapter XVIII). The invention of the basic process failed to stimulate the extraction of the phosphoric clayband ores. These ores, occurring in thin seams, were expensive to mine, and as they necessitated the employment of special furnace linings when used for steel making they could not compete with rich foreign ores needing the acid linings which could so easily be supplied by the refractory sandstones of the local Millstone Grit outcrop. Since 1872, when over a million tons were raised, the production of clayband ores has rapidly declined and has now almost ceased except as a by-product of certain coal mines.

The result of all these changes has been the virtual extinction of smelting at the inland centres. In place of the 170 furnaces which existed in the 'seventies of last century, there are now less than 10. The only active plants between 1929 and 1938 were those at Port Talbot, Briton Ferry, and Cardiff—each of which is situated on the dock-side. The north-eastern region, hard hit by the working out of the best coals, became extinct as a producer of iron and steel, and the huge works, as at Dowlais and Blaenavon, were closed down and dismantled. The disadvantages of this area were lack of ore and distance from the coast. In competition with coastal works, the use of foreign ore became impracticable, and the import of lean Jurassic ores by rail from Oxfordshire and Northamptonshire ceased to be an economic proposition. In 1936, however, abandoning their plan of transferring most of their Welsh plant to the more natural centre of Scunthorpe, Richard Thomas & Co., with government assistance, embarked on a gigantic scheme, which has cost at least £10 millions, of completely rebuilding the Ebbw Vale works, with blast furnaces, Bessemer converters, rolling mills, and tinplate works; Northamptonshire ironstone is railed 150 miles across country from Wellingborough to feed the furnaces. The geographical disadvantages remain, but the available land and the desire to alleviate the social distress within the area no doubt prompted the decision.[1] Other steel producers in the eastern area are nearer the coast—at Cardiff, Newport, Cwmbran, and Pontymister.

In the western area, the expansion of the tin-plate trade has been accompanied by a great increase in the productive capacity of the steelworks, all of which are linked in greater or less degree with groups of tin-plate mills.[2] The tin-plate industry is capable of

[1] It is only by operating on a huge scale that such an enterprise can be successful—but the introduction of vast new tin-plate producing capacity into South Wales had an immediate effect in threatening with extinction many of the smaller producers in the Swansea area, and the wisdom of relieving distress in one area while creating it in another would seem doubtful.

[2] See *Industrial Survey of South Wales*, 55. Cf. Figs. 197 and 198.

consuming up to a million tons per annum of mild, soft steel, and almost the entire output of the steelworks is open-hearth steel of this particular quality, only the Port Talbot and Margam works producing steel for plates, rails, and sections. The local pig-iron output, however, is quite incapable of satisfying the demands of the steelworks, and large quantities of foreign pig-iron and steel bars are imported, supplemented by a big tonnage of scrap which open-hearth furnaces can consume.

In South Wales, as in the Cleveland district, vertical integration is a feature of the modern industry. The British (Guest, Keen, Baldwins) Iron and Steel Co., formed in 1930, controls collieries, coke ovens, blast furnaces, steel, and tin-plate mills, and various subsidiary industries like tube manufacturing, slag-brick making, and the quarrying of refractories.

(5) *Lincolnshire.*[1]—Lincolnshire is the latest arrival in the British iron and steel industry: the first furnace was lighted in 1864. The localisation of the works is due entirely to the existence of the thick, though lean, Lower Lias ore in the neighbourhood of Frodingham and Scunthorpe. The greater thickness of the ore-bed here and its occurrence over a comparatively small and compact area has permitted a far greater concentration of the smelting industry on this field than is the case, for example, in Northamptonshire. The area is well situated with regard to fuel supplies and export facilities. The nearest mines of the Yorkshire coalfield (in which the Barnsley seam produces good coke) are less than 15 miles to the west, and the port of Grimsby lies only 25 miles to the east. The limy nature of the ore, as we have seen, necessitates the import of siliceous Northampton Sands ore from South Lincolnshire, but the presence of appreciable quantities of manganese renders it rather more suitable for basic steel making than the Northamptonshire ore. Owing to this fact, and to the compact nature of the industry, this group of works received a marked stimulus during 1914–18, and the production of steel is now five times what it was in 1913. As the ironstone field is estimated to have a future of some 200 years before it, and as the Yorkshire coal mines are creeping nearer and nearer to it from the west, the area will undoubtedly increase in importance. The momentum of other areas may prevent its participation to any great extent in the engineering industry, but it will remain a pillar of strength as a producer of the raw materials of that industry. Pig-iron is sent to Yorkshire, Lancashire, Staffordshire, and Scotland, and Frodingham steel girders are becoming more and more in evidence all over the country in constructional work.

(6) *The Western Midlands* (Black Country, etc.).—Even in the days of charcoal smelting the Black Country, by virtue of its accessible coal supplies,[2] developed an extensive finished iron industry,

[1] O. D. Kendall, "Iron and Steel Industry of Scunthorpe," *Econ. Geog.*, XIV, 1938, 271–281.

[2] Coal furnaces were used to heat the iron for forging.

based upon bar-iron obtained either from Shropshire and Worcestershire or imported *via* the River Severn from Sweden. The western centres grouped in the Stour valley made use of water-power for rolling out the iron into sheets; the eastern group, around Birmingham, specialised more in forging. The introduction of coke smelting at once placed the Black Country and the Coalbrookdale area in a more favourable position. Rich coal and iron seams occurred in the same measures, a supply of flux was locally available in the Wenlock limestone hills of Dudley, and the people were already skilled in iron and metal working. The result was the creation of that vast smelting industry which earned for the South Staffordshire region its unenviable title. At the beginning of the nineteenth century the two counties of Staffordshire and Shropshire accounted for 40 per cent. of the pig-iron production of Great Britain. The utilisation of the blackband ores of North Staffordshire brought the smelting industry into the Potteries.

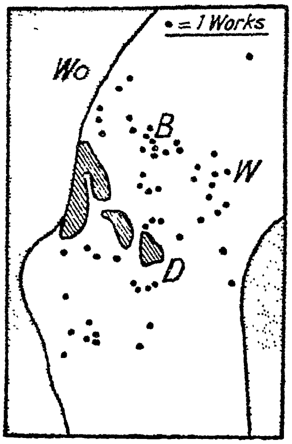


FIG. 195.—The "Black Country" iron smelting works in 1830.

The coalfield is unshaded: the dark areas are outcrops of pre-Carboniferous rocks including limestone (see Fig. 162). The stippled areas are unproductive Upper Coal Measures and Trias.

D = Dudley; W = Wednesbury; B = Bilston; Wo = Wolverhampton.

Great changes have taken place in the iron and steel industries of the western Midlands within the last half-century. The working out of the best coal seams in South Staffordshire and Shropshire has been accompanied by the abandonment of iron mining. For a time the smelting industry continued to survive by making use of Jurassic ore from Northamptonshire,[1] but gradually the impossibility of competing on level terms with more favourably situated areas led to decline of pig-iron manufacture. The number of furnaces now in Staffordshire is under 30, compared with the 200 or so which existed in the early 'fifties. The majority of these, moreover, are now obsolete. In North Staffordshire, near Stoke-on-Trent, the blackband ironstones, mixed with Northampton Sands and Marlstone ores, are still employed. In the south, the works at Bilston uses Northamptonshire and Oxfordshire ores. The West Midland iron and steel industry is thus running on "geographical momentum." The true Black Country now produces but little coal and no iron ore, and, as a result, has come to

[1] The South Staffordshire output of pig-iron was 597,000 tons in 1858. By 1884 it had declined to 279,000 tons, 80 per cent. of which was made from Northamptonshire ore.

specialise to an increasing extent in steel-making, fostered to a large extent by the huge supplies of scrap available from the engineering industries.[1] Large quantities of foundry pig-iron are imported from Northamptonshire for working up into cast-iron articles, and this area is one of the most important districts in Britain still using forge pig-iron for making wrought-iron goods. It is also the principal district in Britain for the re-rolling of steel.

(7) *The remaining areas* (except Sheffield).—The remainder of the British iron and steel industry falls into several groups. In general, pig-iron for foundry work is the chief product; the steel output is only about two-thirds as great, but the proportion is increasing, largely owing to the developments in Northamptonshire. Most of the works are supplied with ore from the marlstone of Oxfordshire and Leicestershire, and from the Northampton Sands field (cf. Fig. 190). Three principal groups of furnaces may be noted: (*i*) *Derbyshire and south and west Yorkshire*, grouped around four centres, in south Derbyshire (Ilkeston), in north-east Derbyshire (Chesterfield), in south Yorkshire (Rotherham), and in west Yorkshire (Bradford). All these works owe their origin to the clayband ores which were formerly mined in conjunction with the valuable coal seams which occur near the base of the Middle Coal Measures. In the Leeds–Bradford area, the Black Bed ironstone and the Better Bed coal were used, and this region was long famous for "Best Yorkshire" wrought iron. The last surviving works, at Low Moor, was dismantled in 1938. In south Yorkshire the Tankersley ironstone and the Silkstone and Park Gate coals provided the basis for the industry which still flourishes in the Rotherham area, where iron, steel and foundry products (notably grates and stoves) are made. Further south, in the Chesterfield area, the Brimington anticline brought the Silkstone coal and several useful ironstone seams nearer to the surface and so localised the furnaces at Sheepbridge and Staveley, where the speciality is iron pipes for water and gas mains. Further south still, the Erewash valley anticline, bringing the valuable Top Hard (Barnsley) coal to the surface, localised a group of furnaces of which the Stanton works near Ilkeston, world-famous for iron pipes, is the only survivor. All these works now depend entirely on Jurassic ores, and their output is concerned far more with pig-iron and foundry products than with steel. (*ii*) *South Lancashire and North Wales*.—The existence of a coal supply and the local demand for textile machinery, together with the availability of imported ore supplies *via* Liverpool, gave rise to the iron industry in South Lancashire, and in North

[1] An interesting survival of a former age is to be found at the Earl of Dudley's Round Oak Works, where a cold-blast furnace is still producing special iron for making the outside surface of rolls for steel mills, and for chains. Another cold-blast furnace exists at Grazebrook's Dudley ironworks.

Wales the usual association of coal and ironstone in the Flint and Denbigh coalfield led to its development. What remains is either modern or specialised, however. The smelting works at Wigan and Darwen have long been extinct, and the only works in South Lancashire is the modern plant at Irlam, alongside the Ship Canal; this depends on ore from Northamptonshire and abroad. The huge steelworks at Shotton are likewise modern and located on navigable water at the head of the Dee estuary; the Mostyn ironworks, also on the Dee estuary, makes special types of iron, and the only relic of the old industrial régime is the Brymbo iron and steel works, near

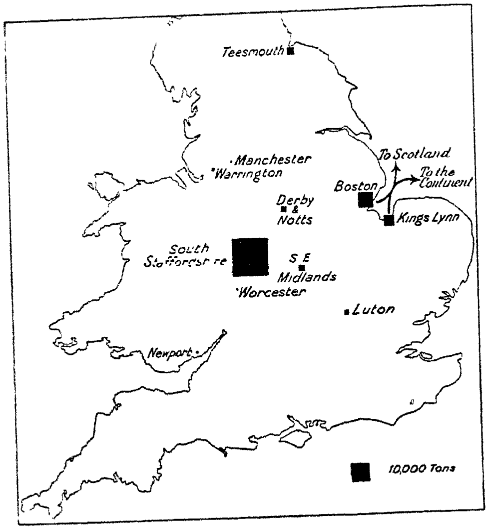


FIG. 196.—Map showing the destination of pig-iron made at Wellingborough, Northamptonshire, in 1929.

Total tonnage forwarded, 58,458 tons. This is given as an example of the areas supplied with pig-iron made on the Northamptonshre orefield.

Wrexham, which played almost as important a part as Coalbrookdale in the early history of the iron industry. (*iii*) *Northamptonshire and Leicestershire.*—In Northamptonshire, as at Frodingham, the local ore supplies gave rise to an industry away from the coalfields. The start was slow, for the inland situation and the great momentum possessed by the Midlands as iron producers prevented the rise of an industry comparable with that which developed, based on similar ores, at Teesmouth. Moreover, the distance from coal and from the coast prevented the rise of a basic steel industry, and the phosphoric ore produces an easily flowing pig-iron which is admirably adapted for making cast-iron articles. The area has thus remained as a producer mainly of foundry and forge pig-iron for (*a*) the vast metallurgical industries of Staffordshire; (*b*) the

scattered foundry and engineering industries of the south-eastern portion of Great Britain. Some pig-iron is also exported coastwise *via* Boston to Scotland. The chief centres of the smelting industry are near Melton Mowbray, in Leicestershire, and at Kettering, Wellingborough, and Corby, in Northamptonshire. The last-named village, which saw its first blast-furnace in 1910, has since 1933 been transformed into an industrial town by one of the outstanding developments of the century. Messrs. Stewarts and Lloyds have erected a huge plant, containing coke ovens, blast furnaces, Bessemer converters, rolling mills and a tube factory, in the heart of the Northamptonshire ironfield. The distance from a coalfield, the requirements of the tube industry, and the nature of the ores, led to the adoption of the basic Bessemer process, thus reviving a branch of the steel industry which had been extinct for a decade. So Northamptonshire is at last following the same industrial path as Lorraine, and its future prospects appear to be very bright.

(8) *Sheffield*.[1]—Sheffield must be considered separately, because its industry is so very different from that of the remainder of the area in which it is situated. In common with the neighbouring regions, the Don valley and its tributaries developed, as early as the twelfth century, an iron industry based upon Coal Measure ironstones, local charcoal supplies, and plentiful water-power. The Carboniferous Gritstones of this region making excellent grindstone material, specialisation commenced in the manufacture of cutlery.[2] The impurity of the local ores, however, rendered necessary the import of pure bar-iron from Spain and central Sweden for the finer work. Thus, over 400 years ago, began a branch of the steel industry which, largely owing to the "deposit" of skilled labour which has accumulated, has remained localised in this region. The only essential changes which have occurred are (1) the concentration of the more recently developed heavy steel industries in the Don valley between Sheffield and Rotherham, whilst the manufacture of cutlery and the lighter types of goods is more localised higher up in the Sheaf valley in the centre and south of Sheffield; and (2) the specialisation in the finest types of steel goods and in such articles as need a large amount of skilled labour expended upon a small quantity of raw material; this is a result of the inland position and the absence of local ore supplies.

The development of the steam engine and of iron and steel ships gave Sheffield new opportunities for producing fine steel forgings for the crankshafts and axles and, later, huge castings for turbine engines; the constant

[1] For a brief history of the Sheffield steel industry, see Lord Aberconway: *Basic Industries of Great Britain*, Chapter III; also R. N. Rudmose Brown: "Sheffield: its rise and growth," *Geography*, XXI, 1936, 175–184.

[2] This was encouraged by the settling of skilled Flemish immigrants in the district in the sixteenth century.

necessity for improvement in armour-plating and in guns and shells for destroying it opened up further fields;[1] the perfection of high-speed tool steels since 1900 has expanded the steel market still further; whilst the development of chrome-iron alloy, which produces stainless steel,[2] just before the War of 1914, and the subsequent use of this material not only in the cutlery trade but also for an ever-expanding list of products in the engineering industry, have insured that, despite its inland position, Sheffield's accumulation of plant and skill will continue to maintain the special branches of the steel industry for which the town is justly famed. The industry underwent a considerable expansion in productive capacity during 1914–18, when the demand for shells, guns, bombs, "tin-hats," marine and aeroplane engines, and "tanks" rose to enormous proportions. As a result the output in 1930 was nearly 50 per cent. in excess of the 1913 figure. No pig-iron is made at Sheffield; the large requirements of high-grade iron are imported from abroad, or from Cleveland or Cumberland. There is also a considerable import of the materials used in producing special steels, *e.g.* chromium, manganese, tungsten, nickel, and molybdenum. Most of the steel for the heavy industries is now made by the open-hearth process from Spanish or Cumberland iron, but considerable quantities of fine steel for the cutlery trade are produced from the purest Swedish iron in electric furnaces and in crucibles.

NOTE ON LOCATION FACTORS IN THE IRON AND STEEL INDUSTRIES

It is important to realise that iron-smelting and steel-making can be, and often are two quite separate industries, with different location factors. The iron-smelting industry may be located (*a*) on its source of fuel, *i.e.* on coalfields; this type of location is mainly a survival of former times (*e.g.* Chesterfield, Coatbridge); (*b*) on the ore-fields, especially if the ore is of low grade (Scunthorpe, Wellingborough); (*c*) at ports, whether near coalfields or orefields or neither, but where foreign ores are available (Cardiff, Middlesbrough, Workington, Dagenham). The steel-making industry has as its main raw materials iron, either molten or in pig form, and scrap. It may be located (*a*) adjacent to a blast-furnace works, where molten iron from the furnaces can be converted directly, without loss of heat, into steel (Middlesbrough, Workington, Scunthorpe); (*b*) adjacent to its market (*e.g.* western South Wales, where almost all the output goes into the tin-plate mills); (*c*) in an engineering area where abundant scrap is available and the engineering works form a market for the output (*e.g.* Wednesbury, Motherwell). Naturally, in a country in which the industries are as old-established as they are in Britain, and in which distances between coal, ore and ports are in no case great, many works fall into more than one category.

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[1] Several armour-plate firms, *e.g.* Brown, Cammell Laird, and Vickers, have extended their interests and now use their Sheffield products in their own shipyards.

[2] See Marshal and Newbould: *The History of Firths,* 1924. Stainless steel contains about 18 per cent. by weight of chromium and 8 per cent. nickel.

CHAPTER XVIII

IRON AND STEEL[1]—(*continued*)

THE IRON AND STEEL TRADE; THE SECONDARY INDUSTRIES (TIN-PLATE, SHIPBUILDING, ENGINEERING)

The Iron and Steel Trade

IN the last chapter the rise and growth of the British iron and steel industry from earliest times has been briefly traced. There remains to be examined the position which the British iron and steel industry now occupies amongst the world's great producers.

The following table shows the relative importance of the five principal iron and steel producing countries in the "boom" year of 1929 and in 1935:

	Pig-iron, per cent.		Steel, per cent.	
	1929	1935	1929	1935
United Kingdom	8	9	9	10
United States	44	29	48	35
Russia	4	17	4	12
France	10	8	9	6
Germany	13	17	14	16
World production (million tons)	97	73	118	96

The most striking feature of this table is, of course, the remarkable expansion of iron and steel production in Soviet Russia; but it is clear that Britain has "weathered" the great depression of 1931–33 much better than the United States or France, for example. There are numerous economic reasons for this, which are beyond the scope of this book, but two notable features which have undoubtedly contributed to the maintenance and expansion of British iron and steel production are the imposition, from 1933, of a high tariff (generally 20 or 33⅓ per cent. *ad valorem*) on iron and steel products imported from foreign countries, and the economic reorganisation of the industry which followed the creation of a central co-ordinating body—the British Iron and Steel Federation—in 1934. Under the

[1] By S. H. Beaver.

obtained as coal to feed the coke ovens. The coke is made on the spot; the waste gases yield by-products and can be used, perhaps combined with blast-furnace gases, for domestic or industrial purposes or burnt in gas engines or under boilers to create electric current; the coke is used in the blast furnaces; the molten iron is converted into steel immediately, without cooling, in the steelworks, and the rolling mills are driven by the electricity generated by the aforementioned gases. Thus it is possible, as at one Scunthorpe works, to make a ton of rolled steel with the expenditure of no more than 30 cwts. of coal—a performance which would have been incredible only a few decades ago. Moreover, the sale of the by-products—tar, ammonia, slag for road metal or fertiliser, gas and electric current—helps considerably to reduce the costs of production.

Let us now examine the British foreign trade in iron and steel, observing especially its geographical bases and the post-war trends of development.

IRON AND STEEL TRADE, 1913 AND 1921–36

Year	Total volume of trade (thousand tons)	Ratio of Imports	and Exports
1913	5,944	36	64
1921	2,906	57	43
1922	3,256	27	73
1923	4,486	30	70
1924	5,077	48	52
1925	5,227	52	48
1926	5,694	66	34
1927	7,461	59	41
1928	5,907	49	51
1929	5,909	47	53
1930	5,126	57	43
1931	4,138	69	31
1932	2,739	58	42
1933	2,164	45	55
1934	2,979	46	54
1935	2,907	39	61
1936	3,125	48	52

Several features displayed in the above table call for comment. Whilst the total traffic in iron and steel (*i.e.* imports plus exports) had at times regained its 1913 figure, the relative volume of the imports and exports has changed. No longer do the exports comprise two-thirds of the total trade, and, except for 1922–23, when Britain was still supplying large quantities of iron and steel to the devastated areas of continental Europe, the years 1921–36 show the imports and exports oscillating around the 50 : 50 ratio, sometime in Britain's favour, at other times, as during industrial

depressions, in the opposite direction. It is obvious, then, that the imports have increased whilst exports have decreased. It is very important to remember, however, that these figures refer only to the primary products. The export figures do not represent the sum total of the results obtained from the British iron and steel industry, and if we were to include the secondary products—tin-plates, machinery, and ships (all of which are based upon iron and steel, but employ other metals as well) the total export trade would well outweigh the imports.[1]

It is perhaps surprising at first that an industrial country like Britain, with such a wealth of coal and iron ore, should import such large quantities of iron and steel. But Britain's advantages for cheap mass production are not what they were, and even in spite of the tariff Continental producers may undercut British manufacturers in certain types of crude or semi-finished products. Moreover, the coastal situation of many of the British engineering works is a factor very favourable to the import of these types of goods.

The following table compares 1913 with post-1918 years as regards iron and steel imports.

Iron and Steel Imports by Varieties

(Thousand Tons)

Items	1913	Average 1921–25	Average 1926–30	1931	1932	1933	1934	1935	1936
Blooms and billets	514	430	712	531	361	230	331	262	452
Sheet and tin-plate bars	345	241	593	720	380	84	124	100	95
Steel bars, angles, shapes	134	104	359	330	240	187	281	231	181
Plates and sheets	169	112	219	144	74	36	44	48	42
Iron bars, rods, angles	200	155	221	120	47	15	12	12	18
Hoops and strips	72	35	159	135	120	79	99	66	54
Girders and beams	109	67	153	116	70	78	100	87	69
Wire rods	95	62	118	75	25	42	85	85	87
Pig-iron	185	294	307	284	140	93	126	84	247
Other varieties	411	308	514	390	135	127	164	177	238
Total	2,231	1,799	3,355	2,845	1,592	971	1,366	1,152	1,483

Totals: 1937, 2,033; 1938, 1,340.

[1] The following figures, for 1929, are suggestive:

Imports (thousand tons)		Exports (thousand tons)	
Iron and steel (as above)	2,822	Iron and steel (as above)	3,087
Machinery	113	Tin-plates, etc.	1,292
		Machinery	562
		Ships launched for foreign owners	260
Total	2,935	Total	5,201

The large proportion represented by "raw" or "semi finished" steel (the first four sets of items) will be noticed.

Whilst a large number of ports deal with this import trade, the principal ones show very definite correlation with the situation of the iron and steel industries.

TABLE OF CHIEF PORTS IMPORTING IRON AND STEEL, 1929 AND 1935
(Thousand Tons)

	1929	1935		1929	1935
Newport	431	282	Stockton	95	23
London	427	146	Cardiff	78	25
Manchester	333	86	Middlesbrough . . .	73	19
Grangemouth . . .	274	85	Port Talbot	71	1
Glasgow	188	77	Newcastle	50	26
Liverpool	180	28	Swansea	49	15
Bo'ness	142	31	Other ports	227	160
Goole	105	59			
Hull	99	65	Total . . .	2,822	1,152

The South Wales ports are the chief group (especially Newport), not a very surprising fact when we recollect the size of the steel-making and tin-plate industries in that area compared with the simple smelting industry. London occupies an important position in this trade as in most others (cf. Chapter XXV), importing large quantities of the semi-finished type of goods (as opposed to steel ingots) for its own numerous industries or those of south-eastern Britain. Manchester, Liverpool, Goole, and Hull import

IRON AND STEEL IMPORTS BY COUNTRIES
(Thousand Tons)

Country	1913	Average 1921–25	Average 1926–30	1931	1932	1933	1934	1935	1936
Belgium	584	879	1,900	1,478	915	500	602	518	438
Germany	1,198	227	517	525	96	77	145	78	129
France	37	336	494	444	206	115	174	165	253
Sweden	209	59	70	46	17	51	64	61	87
United States . . .	154	79	66	47	3	4	9	10	18
Luxembourg	?	136	95	100	87	59	124	110	115
Other countries . . .	49	111	213	205	268	165	248	210	443
Total	2,231	1,759	3,355	2,845	1,592	971	1,366	1,152	1,483

for the industries of South Lancashire and Yorkshire, whilst Grangemouth, Glasgow, and Bo'ness receive material for the Scottish industry which, as we have seen, is now almost without local raw material (cf. p. 355). The absence of north-east coast ports from

the leading places in the above list is due very largely to the huge import of iron ore into this region (p. 351), which thus produces most of its steel on the spot and has no need to import in such large quantities.

As regards the origin of these imports, it is only natural to expect that our near continental neighbours should supply the greater proportion; but it is very noticeable how, since the War, the reconstructed Belgian and French industries have increased their exports to Britain to the detriment of the more distant German and Swedish producers.

Turning now to the exports (excluding tin-plate and galvanised sheets), we find that finished iron and steel products, in the form of tubes and pipes, railway rails, etc., bulk largely in the total, although plates, sheets, and angles, which form the raw materials of shipbuilding, and many other engineering industries, are equally important. One result of this is that the value per ton of the exported iron and steel is greater than the value per ton of the imported goods. In 1929, for example, the value of the imports was just under £9 per ton, compared with a little over £14 per ton for the exports.[1]

Iron and Steel Exports by Varieties
(Thousand Tons)

Items	1913	Average 1921–25	Average 1926–30	1931	1932	1933	1934	1935	1936
Plates and sheets	204	332	389	191	251	213	305	338	293
Pig-iron	945	466	335	190	121	108	123	144	100
Tubes and pipes	400	216	376	204	218	273	339	325	301
Railway rails	500	220	310	106	41	55	113	93	143
Steel bars and angles	251	238	266	117	90	127	193	232	203
Miscellaneous	1,415	920	989	485	426	384	540	623	602
Total	3,713	2,391	2,665	1,293	1,147	1,193	1,613	1,755	1,642

Totals: 1937, 1,877; 1938, 1,470.

It is noteworthy that the total volume of the exports has never since the War reached its 1913 figure. The decline is especially evident in the cases of pig-iron, of which Britain is producing much less and the Ruhr, Belgium, and Lorraine a good deal more than in 1913,[2] and of railway rails for which, with the slowing up of new construction in the colonies and other "new" countries, there is a

[1] Imports 2,816,000 tons, value £24,670,000. Exports 3,087,000 tons, value £45,342,000.

[2] Pig-iron production (thousand tons):

	1913	1929	1935
Britain	10,260	7,589	6,424
Ruhr	8,209	10,985	9,086
Lorraine	9,857	10,024	4,595
Belgium	2,485	4,040	3,060

decreased world demand. Whilst, as with imports, numerous ports deal with this traffic, the concentration on a few large ones is again noticeable.

CHIEF PORTS EXPORTING IRON AND STEEL (Including Tin-plates and Galvanised Sheets), 1929 and 1935
(Thousand Tons)

	1929	1935		1929	1935
Liverpool	1,068	600	Workington	75	18
Middlesbrough	761	335	Manchester	69	74
Swansea	626	399	Newcastle	65	20
Glasgow	606	308	Cardiff	63	14
Newport	284	155	Grimsby	50	35
London	278	189	Other ports	142	140
Barrow	112	29			
Bristol	96	8			
Hull	84	47	Total	4,379	2,371

Note.—Of the totals given here, 1,292,000 tons (1929) and 616,000 tons (1935) is represented by Tin-plates and Galvanised Sheets, which form the bulk of the export from the South Wales ports (Swansea especially) and a smaller proportion of the export from Liverpool. Unfortunately, the tin-plate trade is not separately distinguished in the official trade statistics.

The outstanding position of Liverpool is due not only to its position as the natural outlet for such a large iron and steel-producing area (South Lancashire and West Yorkshire), but also to its regular shipping connections with all parts of the world (cf. Chapter XXV).

The destination of the iron and steel exports shows a marked British Empire bias.

IRON AND STEEL EXPORTS BY COUNTRIES
(Thousand Tons)

Country	1913	Average 1921–25	Average 1926–30	1931	1932	1933	1934	1935	1936
India and Ceylon	567	388	346	122	91	110	168	212	180
Australia	434	239	258	32	51	60	96	83	80
South Africa	219	117	153	151	77	117	208	258	286
New Zealand	127	78	80	44	34	30	61	70	71
Canada	145	46	61	58	57	46	70	81	71
Straits Settlements	59	30	52	20	15	17	33	41	60
Argentina	264	77	248	72	50	63	74	112	95
Belgium	112	103	77	26	15	12	26	25	23
France	181	73	65	42	18	20	22	20	24
Denmark	60	32	24	18	18	28	79	86	84
U.S.S.R.	63	1	—	—	105	20	80	70	10
China	36	27	13	21	23	17	92	40	56
Japan	174	142	126	37	21	16	24	13	13
Other countries	1,272	1,015	1,162	650	572	637	580	644	589
Total	3,713	2,391	2,665	1,293	1,147	1,193	1,613	1,755	1,642

The most serious feature shown by this table is the decline in the tonnage exported to India and Australia. It is satisfactory to notice, however, that the Argentine market, which owing to the War was lost for a period to the United States, has been partly recovered.

The Subsidiary Industries

The iron and steel industry obviously does not come to an end with the casting of steel ingots and the rolling of plates, bars, and rails. Ingots, plates, and bars, although the finished products of the steel furnaces and mills, are the raw materials of a number of other industries which thus depend for their existence upon the output of the home steel industry or upon the imported material. Chief amongst these are shipbuilding, tin-plates, galvanised sheets, rails, tubes and pipes, constructional steelwork, castings (grates, etc.), wire and wire-products (netting, nails, etc.), and the various industries concerned with the manufacture of engines and machinery, and their constituent parts (cf. p. 338). To describe all of these would be impossible within the limits of a single chapter. We may, therefore, confine our attention to a few which are interesting as exhibiting the influence of certain geographical factors in their distribution. Three groups of industries will be studied :

(*a*) *The Tin-plate industry* and its allies, concerned with the covering of thin steel sheets with a coating or film of tin, zinc, or a mixture of tin and lead ;

(*b*) *The Shipbuilding industry*, employing vast quantities of thick steel plates and girders ; and

(*c*) The miscellaneous *Engineering industries*, depending for their raw material upon foundry and forge iron from the blast furnaces and various forms of " semi-finished " steel from the mills.

A few simple geographical considerations will show us certain definite localising factors in each of these groups. In the case of the tin-plate industry the bulkiest raw material is the steel plate which is to be coated ; moreover, the tin has to be imported and the bulk of the produce is destined for export. It would seem, then, that a situation within one of the great seaboard steel-producing areas is most favourable. With shipbuilding we shall likewise expect to find a concentration only on those navigable estuaries or sheltered waters where the heavy iron and steel industry is also developed. The engineering industries, however, being concerned, generally speaking, with smaller and more valuable products, do not show the same tendency to be concentrated in close proximity to the parent industry ; in fact, since the finished articles are usually more costly to transport than the raw materials of which they are composed, we shall often find that whilst the bulk of the heavy engineering industries are concentrated upon the coalfields,

in the case of the lighter types of engineering product the existence of a market for the goods exercises as much control over the location of the industry as do the sources of raw materials.

The Tin-plate and Allied Industries [1]

The art of giving a coating of some non-ferrous metal to a thin sheet of iron, in order to preserve it, was first practised in Bohemia about the fourteenth century. The metal used was tin and the sheets thus became known as "tin-plates." Subsequently the metals zinc and lead have also been employed for the same purpose, giving rise to the trade names "galvanised sheets" (coated with zinc) and "terne plates" (coated with a mixture of tin and lead).[2]

The first successful attempt to make tin-plate in Britain took place in 1720 at Pontypool, where a small iron industry already existed, and a good water supply was available for working the hammers which produced the flat plates, and for washing the plates before tinning. From this small beginning grew the great industry in South Wales. Its growth was aided by two subsequent events: first the invention in 1728 of a method of rolling plates (a much quicker and more efficient process than hammering), and secondly the substitution of coal for charcoal in the iron-smelting industry, permitting a much greater output. By the end of the eighteenth century a dozen works were producing tin-plate, and our imports of that commodity had been replaced by a growing export trade. The industry spread rapidly during the first half of the nineteenth century, especially in Monmouthshire, Glamorgan, Gloucestershire, and Staffordshire (the last two supplied with iron from the Forest of Dean). All the works, however, were subsidiary to pre-existing smelting works or forges which were favoured with abundant water supply.[3] The reasons for this early concentration in South Wales are not clear and decisive. Probably the chance selection of Pontypool as the first site for a tin-plate works prompted other ironworks in the neighbourhood to adopt this profitable sideline as an outlet for their iron at a time when the iron industry was not very flourishing; whilst the nearness of South Wales to the Cornish tin supplies may also have given that area an advantage. In addition, the momentum derived from an early start sufficed to maintain the supremacy of South Wales in the industry even when the methods of production were radically changed; whilst the inland position of Staffordshire, and the decline of the iron

[1] See J. H. Jones: *The Tin-plate Industry;* Rider and Trueman: *South Wales,* Chapter X; E. H. Brooke: *Monograph on the Tin-plate Works in Great Britain.*

[2] The name "terne" reflects the fact that such plates are composed of *three* metals—iron, lead, and tin; but it may also be derived from the French *terne* =dull or tarnished, in view of the contrast with the brightness of tin-plate.

[3] See Darby: "Tin-plate Migration in the Vale of Neath," *Geography,* XV, 1929, 30–35.

industry in the Forest of Dean, prevented the rise of those areas in competition with South Wales.[1]

The last quarter of the nineteenth century witnessed vast changes in the nature and location of the tin-plate industry. By the early 'seventies Malayan tin had replaced the failing supplies from Cornwall, but this was of minor importance compared with the substitution of mild steel plates for wrought-iron plates. Acid open-hearth steel suitable for rolling into thin plates was first produced at the Landore works (near Swansea) in 1875, and the cheapness of steel compared with puddled iron, together with its greater suitability—steel plates having a smoother surface which absorbed less tin—soon resulted in its adoption in the tin-plate works. But acid steel could only be made from imported pig-iron, and in consequence steelworks, followed by tin-plate mills, began to be set up in the neighbourhood of the ports of Llanelly, Swansea, and Briton Ferry, and the "centre of gravity" of the tin-plate industry in the vales of Swansea and Neath migrated down-stream. Eight new steelworks, all associated with tin-plate mills, were erected between 1875 and 1900. Many of the older tin-plate works persisted, and still exist to-day; but the momentum possessed by an individual works—usually a small, comparatively inexpensive unit—was not great, and in consequence migration was not difficult. This "reshuffling" of the industry in the 'eighties, combined with the economic disaster produced by the American tariff of 1890, which almost cut off our chief market for tin-plate, naturally resulted in a period of depression, but the present century has witnessed a great expansion of the tin-plate trade, and a remarkable concentration of the industry upon the Swansea-Llanelly region.

Before considering the reasons for this development, let us further examine the nature and methods of the industry. Tin-plates are finding new uses almost every day, and the expansion of the petroleum industry, and of canning industries of all kinds, has naturally been accompanied by a great increase in the production of the tin-plates from which the containers are made. Tin-plate makes the only metal container capable of being hermetically sealed, and is perfectly safe for the canning of vegetables, fruit, fish, meat, and every other kind of perishable article. Although Britain is gradually developing the refining of petroleum and the canning of fish and fruit, the world's chief consumers of tin-plate lie abroad, in the great oil-producing and fruit-growing regions. The bulk of our tin-plate is thus destined for export. (See table on p. 380.)

[1] In 1850 thirty-five tin-plate works existed, twenty-two of which were in South Wales. By 1875 the total had increased to seventy-seven, fifty-seven of which were in South Wales.

A short résumé of the methods employed in the process of tin-plating may assist us in understanding the localisation of this industry. A raw steel bar is first heated, rolled, doubled over on itself and re-rolled. After this process has been repeated the bar is thus reduced to a series of thin sheets (about $\frac{1}{100}$ of an inch to $\frac{1}{50}$ of an inch in thickness), which are then cut off to the required size and separated. These sheets, known now as "black plates," are then "pickled" in a bath of dilute sulphuric acid to remove the surface scum of oxide, and afterwards "annealed" (softened by heating in a furnace). The annealed plates are cooled and rolled to produce a smooth, shiny surface, and then annealed again to remove the hardness engendered by the cold rolling. A further acid pickling follows, to insure that the plates are perfectly clean, and then each plate is passed successively through (*a*) a bath of zinc chloride (a flux designed to effect a final cleaning and de-hydration, and to render the coating process easier and quicker); (*b*) a bath of pure molten tin, in which it receives a thin coating of that substance;[1] and (*c*) a bath of hot palm oil, which renders the film of tin uniform all over the plate. Large quantities of bran are used to remove all trace of oil from the plate,[2] which is finally allowed to cool and is then dusted and polished by cotton-covered rollers. The plates are then examined by experts for defects and are packed in elm or birchwood boxes for export.

It will be apparent from this description that the needs of the tin-plate industry are as follows:

1. An abundant and cheap supply of steel bars of the required quality.

2. Pure bar-tin and refined palm oil, both of which must be imported from abroad.

3. A supply of fuel for the furnaces. Usually coal-fired furnaces are employed for heating the bars and for the annealing process, but anthracite gas is also used, especially for the tin-bath, with success since it gives a very even heat.

4. A large labour supply, the bulk of which must consist of skilled operatives.

The advantages of the South Wales area as a whole, for the production of tin-plates, were fairly obvious from the start. We have further seen how the industry, following the construction of the coastal steel mills, migrated down-stream to Swansea and Llanelly. The subsequent dominance of this area in the industry needs further explanation, however, and the following reasons suggest themselves:

1. The coal supplies, including the valuable anthracite, are close at hand.

[1] A sheet of tin plate is actually 98 % steel and 2 % tin.

[2] The bran, impregnated with rich oil after use, is an interesting by-product. It is sold for pig meal.

2. Rail communication (*via* Shrewsbury, Brecon, or Gloucester) with the Midlands, which provide the chief home market for tin-plate, is good.

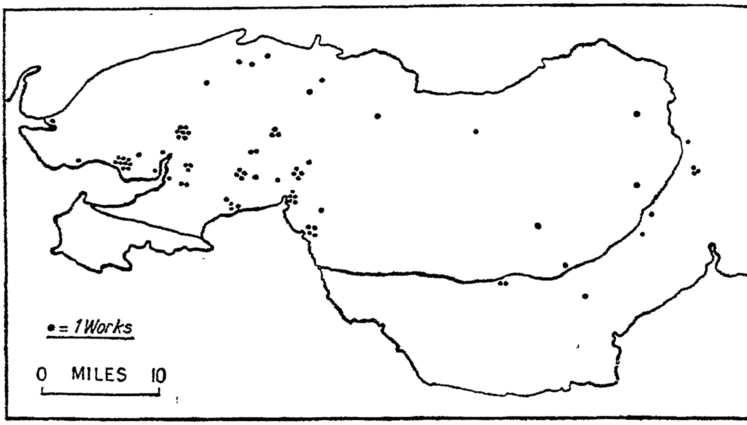

FIG. 197.—Tin-plate works in South Wales, present day.

3. The Swansea area had a large available labour supply, already skilled in metallurgical industries (cf. Chapter XIX); and the decline of copper smelting left much of this available for work in the tin-plate mills.

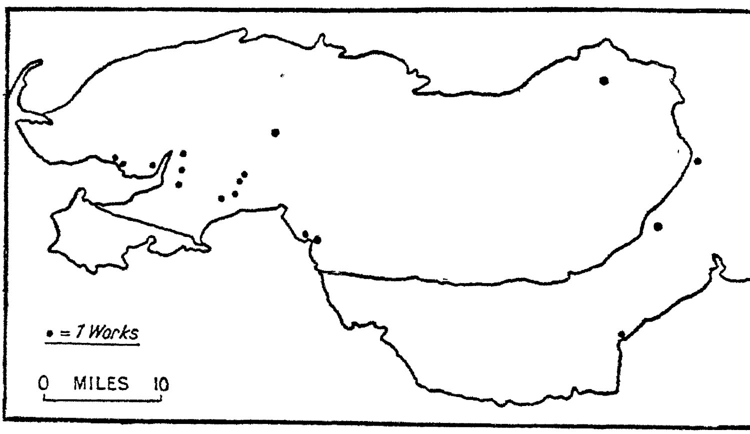

FIG. 198.—Steel works in South Wales.

4. The copper refining and spelter industries of the same area produced as a by-product large quantities of sulphuric acid [1]

[1] During the roasting and smelting processes large quantities of sulphurous fumes are given off. They may be collected and chemically treated to yield sulphuric acid.

which could be employed in the pickling processes in the tin-plate works.

5. The opening of the Prince of Wales Dock, Swansea, in 1882, and the establishment of shipping connections to all parts of the world, resulted in the bulk of the tin-plate trade being done through that port instead of through Liverpool, which had previously had far better world connections. Moreover, the founding of the Swansea Metal Exchange in 1887 tended further to focus attention upon the western region as the metallurgical centre of South Wales.

6. The westerly position, nearer to the open sea than Cardiff and Newport, is undoubtedly a time-saving and cost-reducing advantage, both for the import of palm oil and raw steel (although most of the tin reaches South Wales *via* London),[1] and especially for the export of the tin-plates, boats from Liverpool frequently calling at Swansea for cargoes destined for places with which Swansea has infrequent or no connection of its own.

The distribution of tin-plate works in South Wales, where the industry gives employment to 27,000 people, is shown in Fig. 197. With the exception of a few near Newport, the largest and most important works are all located within a few miles of the coast in the Loughor, Tawe, and Neath valleys, or at the ports of Llanelly, Briton Ferry, Swansea, and Port Talbot.

Isolated centres of the tin-plate industry in Britain are Lydney, Gloucestershire, Stourport, Worcestershire—the last witnesses of the former prosperity of the trade in the Forest of Dean and around the Black Country—and Mold, Flintshire. The last named centre owes its existence largely to its proximity to the port of Liverpool (which is the chief tin-smelting centre in the country), and to the Brymbo steelworks.

The tin-plate industry, after recovering from the slump of 1921, has maintained its tonnage of production at about 800,000 tons per annum, which represents about 75–80 per cent. of the productive capacity. As a result the south-western end of the South Wales industrial region has maintained a much greater degree of prosperity than the north-eastern area (cf. p. 360).

About two-thirds of the output is exported; but the home market for tin-plate is expanding. The tobacco industry requires large quantities, fruit canning is employing larger amounts every year, and the petroleum industry absorbs a vast supply for cans and containers. In this connection it is interesting to note the recent development of oil refining on a large scale at Llandarcy near Swansea.

The exports of tin-plate are almost world-wide in their distribu-

[1] In 1929 London imported 14,618 tons of tin bars and ingots, Swansea only 20 tons.

THE TIN-PLATE TRADE
(Thousand Tons)

	1913	Average 1921–25	Average 1926–30	1931	1932	1933	1934	1935	1936
Production (Tin, Terne and Black Plates)	822	661	766	717	746	767	748	708	815
Retained in Britain	328	203	273	317	283	314	360	363	445
Exported	494	459	493	400	463	453	388	345	370

1937: Prod. 958, Ret. 496, Exp. 462; 1938: Prod. 568, Ret. 239, Exp. 329.

DETAILS OF EXPORTS

	1913	Average 1921–25	Average 1926–30	1931	1932	1933	1934	1935	1936
Australia	29	42	51	37	54	59	57	57	64
Canada	10	28	26	37	34	73	73	70	68
Straits Settlements	17	14	23	14	24	21	19	11	10
India and Ceylon	52	40	18	8	10	6	6	8	4
Argentina	19	21	21	17	28	24	36	21	39
Brazil	14	14	19	18	17	22	9	4	3
Japan	28	23	22	22	39	25	12	8	7
China	15	19	15	16	26	26	8	5	12
Netherlands	43	32	43	37	31	28	30	26	24
Spain	12	18	25	19	13	9	5	2	1
Portugal	14	15	17	19	18	14	7	4	7
Belgium	13	17	19	10	9	7	2	5	9
Norway	25	19	14	9	8	2	1	2	1
Other countries	103	162	180	137	149	137	123	122	109

tion and, with the exception of the United States and Germany, there are few important countries which do not, either regularly or occasionally, receive consignments from Britain.

Black plates (thin steel sheets without the coating of tin) form the basis of the enamelled hollow-ware industry, which is spreading rapidly in South Staffordshire and in other parts of Britain. They are exported either for this purpose, or for conversion into tin-plates by certain countries which, although they can perform the tinning operation, cannot, or do not, produce the required quality of steel.[1]

The manufacture of galvanised sheets is usually carried on by the firms which produce tin-plates, and several of the Welsh tin-plate works have associated sheet mills. When iron was the raw material employed Staffordshire was the chief centre, but with the change over to steel South Wales became the largest producer. The reasons for the concentration of the industry upon the Swansea district are the same as for tin-plate: the necessity for soft steel bars and the dependence on imported zinc and upon foreign markets for the produce. In addition, Swansea is the most

[1] For example, in 1929 30,000 tons were exported—principally to Canada (4·7 thousand tons), Japan (3·2), Netherlands (3·1), the Argentine (2·5), France (2·3), and Brazil (1·7).

important centre in the country for the smelting and refining of zinc (see Chapter XIX). The chief centres of production in South Wales are in the immediate hinterland of Swansea, at Gorseinon, Pontardawe, and Morriston; at Llanelly; and at Pontymister, near Newport. At Bristol the spelter industry of Avonmouth has been a localising factor, and at Mold, Flintshire, the industry is allied to tin-plate manufacture, and was formerly favoured by the proximity of the Flintshire zinc mines. There are also works at Shotton (alongside the great steelworks on Dee-side), and in the Glasgow area.

A coating of zinc protects the steel sheets from corrosion, and galvanised sheets, usually corrugated, are extensively employed

Galvanised Sheet Trade

(Thousand Tons)

	1913	Average 1921–25	Average 1926–30	1931	1932	1933	1934	1935	1936
Production	—	638	788	447	359	367	351	389	362
Retained in Britain	—	100	130	159	81	91	102	118	137
Exported	762	538	658	288	278	276	249	271	225

1937: Prod. 346, Ret. 122, Exp. 224; 1938: Prod. 248, Ret. 101, Exp. 147.

Details of Exports

	1913	Average 1921–25	Average 1926–30	1931	1932	1933	1934	1935	1936
India and Ceylon	242	159	249	62	64	71	67	78	45
Australia	104	88	80	1	3	1	8	19	20
S. Africa	40	33	49	38	27	39	53	42	23
Canada	32	10	10	9	11	4	5	8	7
Argentina	75	65	14	1	1	23	1	1	2
Other countries	269	183	256	177	172	138	115	123	118

for roofing and fencing in tropical countries, where they are far more durable than wood, being unaffected by damp and the ravages of insects. They are also employed to an increasing extent for cisterns and tanks. The production of galvanised sheets in recent years has declined, and is now only about half that of tin-plates, but the proportion exported is much higher—70 per cent. The exports are much more restricted in their distribution than is the case with tin-plates, and about three-quarters of the tonnage is destined for Empire countries.

Terne plates, produced in a similar fashion by using a mixture of tin and lead instead of zinc, are cheaper than tin-plates and galvanised sheets. They are profitably employed for such purposes as roofing, the construction of motor-car bodies, the manu-

THE TIN-PLATE TRADE
(Thousand Tons)

	1913	Average 1921–25	Average 1926–30	1931	1932	1933	1934	1935	1936
Production . . . (Tin, Terne and Black Plates)	822	661	766	717	746	767	748	708	815
Retained in Britain	328	203	273	317	283	314	360	363	445
Exported . . .	494	459	493	400	463	453	388	345	370

1937: Prod. 958, Ret. 496, Exp. 462; 1938: Prod. 568, Ret. 239, Exp. 329.

DETAILS OF EXPORTS

	1913	Average 1921–25	Average 1926–30	1931	1932	1933	1934	1935	1936
Australia . . .	29	42	51	37	54	59	57	57	64
Canada	10	28	26	37	34	73	73	70	68
Straits Settlements .	17	14	23	14	24	21	19	11	10
India and Ceylon .	52	40	18	8	10	6	6	8	4
Argentina . . .	19	21	21	17	28	24	36	21	39
Brazil	14	14	19	18	17	22	9	4	3
Japan	28	23	22	22	39	25	12	8	7
China	15	19	15	16	26	26	8	5	12
Netherlands . . .	43	32	43	37	31	28	30	26	24
Spain	12	18	25	19	13	9	5	2	1
Portugal	14	15	17	19	18	14	7	4	7
Belgium	13	17	19	10	9	7	2	5	9
Norway	25	19	14	9	8	2	1	2	1
Other countries . .	103	162	180	137	149	137	123	122	109

tion and, with the exception of the United States and Germany, there are few important countries which do not, either regularly or occasionally, receive consignments from Britain.

Black plates (thin steel sheets without the coating of tin) form the basis of the enamelled hollow-ware industry, which is spreading rapidly in South Staffordshire and in other parts of Britain. They are exported either for this purpose, or for conversion into tin-plates by certain countries which, although they can perform the tinning operation, cannot, or do not, produce the required quality of steel.[1]

The manufacture of galvanised sheets is usually carried on by the firms which produce tin-plates, and several of the Welsh tin-plate works have associated sheet mills. When iron was the raw material employed Staffordshire was the chief centre, but with the change over to steel South Wales became the largest producer. The reasons for the concentration of the industry upon the Swansea district are the same as for tin-plate: the necessity for soft steel bars and the dependence on imported zinc and upon foreign markets for the produce. In addition, Swansea is the most

[1] For example, in 1929 30,000 tons were exported—principally to Canada (4·7 thousand tons), Japan (3·2), Netherlands (3·1), the Argentine (2·5), France (2·3), and Brazil (1·7).

important centre in the country for the smelting and refining of zinc (see Chapter XIX). The chief centres of production in South Wales are in the immediate hinterland of Swansea, at Gorseinon, Pontardawe, and Morriston; at Llanelly; and at Pontymister, near Newport. At Bristol the spelter industry of Avonmouth has been a localising factor, and at Mold, Flintshire, the industry is allied to tin-plate manufacture, and was formerly favoured by the proximity of the Flintshire zinc mines. There are also works at Shotton (alongside the great steelworks on Dee-side), and in the Glasgow area.

A coating of zinc protects the steel sheets from corrosion, and galvanised sheets, usually corrugated, are extensively employed

GALVANISED SHEET TRADE

(Thousand Tons)

	1913	Average 1921–25	Average 1926–30	1931	1932	1933	1934	1935	1936
Production . . .	—	638	788	447	359	367	351	389	362
Retained in Britain	—	100	130	159	81	91	102	118	137
Exported . . .	762	538	658	288	278	276	249	271	225

1937: Prod. 346, Ret. 122, Exp. 224; 1938: Prod. 248, Ret. 101, Exp. 147.

DETAILS OF EXPORTS

India and Ceylon .	242	159	249	62	64	71	67	78	45
Australia . . .	104	88	80	1	3	1	8	19	20
S. Africa	40	33	49	38	27	39	53	42	23
Canada	32	10	10	9	11	4	5	8	7
Argentina . . .	75	65	14	1	1	23	1	1	2
Other countries . .	269	183	256	177	172	138	115	123	118

for roofing and fencing in tropical countries, where they are far more durable than wood, being unaffected by damp and the ravages of insects. They are also employed to an increasing extent for cisterns and tanks. The production of galvanised sheets in recent years has declined, and is now only about half that of tin-plates, but the proportion exported is much higher—70 per cent. The exports are much more restricted in their distribution than is the case with tin-plates, and about three-quarters of the tonnage is destined for Empire countries.

Terne plates, produced in a similar fashion by using a mixture of tin and lead instead of zinc, are cheaper than tin-plates and galvanised sheets. They are profitably employed for such purposes as roofing, the construction of motor-car bodies, the manu-

facture of drums for containing oil and paint, and in other trades where the presence of lead is not an objectionable quality. They also are a product of the tin-plate mills, and most of the output comes from the Swansea valley.

Shipbuilding

The shipbuilding industry, like the iron industry, has undergone revolutionary changes in its geographical distribution during the last century and a half; and, as in the latter case, the changes have been essentially due to alterations in the nature, and thus the distribution, of the raw materials employed. The requirements of shipbuilding are two:

(1) A navigable waterway, as near to the sea as possible, in which the vessels can be launched.

(2) An easily available supply of the appropriate building materials.

When ships were constructed almost entirely of wood, the presence of fairly good timber supplies in many parts of Britain enabled the industry to be carried on at a large number of small estuaries and harbours all round the coasts, and the ease of import of timber permitted this to survive long after the local supplies were exhausted. The Thames below London and the Tyne were two of the most important centres, and such places as Inverness, Dundee, Whitby, Hull, Bristol, and Newport turned out many of those vessels—merchantmen, whalers, and ships of war—which helped to lay the foundations of the British Empire. The substitution, during the second half of the last century, of iron, and later steel, as the basis of the shipbuilding industry was naturally followed by the gradual decline of all those centres which were remote from the iron and steel-producing regions, and the increased importance of those estuaries, such as the Tyne, Tees, and Clyde, which were in close proximity to such regions.

Anything like a detailed history of the shipbuilding industry is impossible here [1]; we can only indicate in broad outline the general trend of events during the past century. The principal features may be outlined as follows:

1. *Raw Materials.*—Until about 1850 most ships were built of wood and were of quite small size—in 1815 the average size of the vessels in the British Merchant Fleet was 100 tons, and in 1855 the largest vessel in the world, the Cunard "Persia," was only 3,600 tons. The first iron vessel was launched in 1812, and the first iron vessel to cross the Atlantic (the "Sirius") did so in 1838, but even in 1850 only nine per cent. of the new tonnage constructed was of iron. By the 'seventies, however, iron was fast supplanting

[1] A good short summary will be found in *Survey of Metal Industries*, pp. 363–369. Greater detail is given in Pollock, *Shipbuilding Industry*, 1905.

wood as the standard material, and in 1880 under four per cent. of the new tonnage was of wood. From this point, however, steel began to usurp the position which iron had gained and its success, by reason of its greater tensile strength per unit of weight, was assured. By 1900 the new tonnage built of iron had fallen to nil.

The rise of the iron ship proved the salvation of the British shipbuilding industry, for our home timber supplies had been reduced almost to nothing, and the repeal of the Navigation Acts in 1849, by throwing open our commerce to the world's ships, would have put British building at the mercy of other countries, such as the U.S., where abundant timber was available near tide water. The advantageous situation of our coal and iron supplies, however, not only prevented any such catastrophe, but gave to the British industry a stimulus which has maintained its world supremacy ever since.

2. *Method of Propulsion.*—Steam was first used as a method of propelling a ship in 1788, and the steamer "Sirius" crossed the Atlantic in 1838. By 1850, however, sailing vessels still represented 95 per cent. of the total British tonnage, and not until the 'eighties did the sail tonnage begin to drop below the tonnage under steam, since when its decline has been very rapid. The earliest steamships were propelled by paddle wheels. After 1850, however, although many paddle steamers continued to be built, the screw propeller became the more general method. Great advances were made in the efficiency of the steam engines by the employment of the multiple expansion principle; but the greatest revolution came at the end of the century with the introduction in 1897, by Sir Charles Parsons, of Newcastle, of the steam turbine, which is now almost universal amongst fast steam vessels. Much has recently been done to develop the burning of oil by steamships instead of coal. Oil has, of course, the advantages of being less bulky, more easily stored, cleaner and quicker to load, and requiring less man power at the boilers. Great strides have been made also, within the last two decades, in the adaptation of the Diesel engine, consuming heavy oil, to marine propulsion, and the tonnage of motor ships launched annually in the United Kingdom now approximates to that of steam driven vessels [1] (see p. 385). In 1936 (*Lloyd's Register of Shipping*), of a world total of over 65 million tons of shipping, coal-fired steamers represented 32 million tons, oil-fired steamers 20 million tons, and motor-driven vessels just over 12 million tons.

3. *New types of Vessel.*—The development of the giant passenger liner and of the large mixed traffic vessel have added new problems

[1] Some of the largest vessels launched in recent years have been motor ships, *e.g.* 1929, *Britannic*, 27,000 tons; *Winchester Castle*, 20,000 tons; 1930, *Warwick Castle*, 21,000 tons; 1931, *Georgic*, 27,000 tons; 1935, *Athlone Castle* and *Stirling Castle*, each 25,000 tons.

for the boat builder to solve, and the development of specialised traffic has been accompanied by great advances in the technique of marine construction. The conditions which control the design and size of a ship are many and complicated. The type of work which the vessel is to perform plays the greatest part, but, in addition, the physical conditions of the ports of call (such as harbour and dock dimensions and depths), and of any ship canals which may be used, the possibilities of obtaining a traffic which will ensure a return on the initial outlay and, lastly, the numerous regulations of Lloyd's Register or any equivalent classification society, must be taken into account. In the last connection the method of calculating "net tonnage" for the purpose of port and canal dues is often of great importance in affecting details of the ship's construction. We may divide the Merchant Marine into three major classes: (*a*) the cargo boat; (*b*) the passenger liner; (*c*) the vessel designed to carry both passengers and cargo. Important factors which affect the design are:—

1. In passenger vessels the "cargo" of people occupies a large amount of space above the water line, although it is of no great weight. On the other hand, cargo boats have to carry great weights of material which must, for the sake of stability and protection from the sea, be carried in the holds below the water line.

2. Passenger vessels, in the interests of safety, must have numerous water-tight compartments below in order to retain the buoyancy of the ship should any part of the hull be "holed."

3. Whereas the total weight of a passenger liner is not very different empty from loaded, the weight of a cargo boat may be increased by several thousand tons on loading, and in consequence special care must be taken over the design of the framework in order to minimise the disturbing effects of varying displacement.

In addition to these major types, certain other classes of vessel have been developed for special kinds of traffic. Specially designed vessels for carrying coal, ores, and grain in bulk were early developed. More recently, the progress of refrigeration in merchant vessels has produced whole fleets of ships designed to carry cargoes of frozen or chilled meat, fruit or dairy produce,[1] with remarkable results in the distribution of the world's food supplies. Another special design is the "tanker" for carrying oil in bulk—a design which has played a considerable part in the demand for new tonnage in recent years (see table), with the increasing use of oil in transport and industry. Many modern tankers can carry as much as 10,000 tons of oil, which can be loaded and discharged by pipe-line in a few hours.

[1] The first cargo of frozen meat arrived in England from Australia in 1879; the first cargo of fruit from Jamaica in 1896; and the first load of dairy produce from Australia in 1911.

UNITED KINGDOM SHIPBUILDING: TONNAGE LAUNCHED (Excluding Warships)
(Thousand Tons)

Class	1913	Average 1926–30	1931	1932	1933	1934	1935	1936
Steamers:								
Coal fired . . .	1,911	532	60	129	78	144	167	302
Oil fired . . .	—	283	210	55	5	125	80	140
Total steamers .	1,911	815	270	184	83	269	247	442
Motor ships . . .	8	442	228	2	48	189	250	408
Barges, etc. . . .	13	5	4	1	2	2	2	6
Total	1,932	1,262	502	188	133	460	499	856
Tankers (coal and oil fired)	238	287	244	6	3	69	51	149

Geographical Distribution of Shipbuilding

The increase in the size of ships and in the bulk of the machinery and component parts of which they are built has greatly accentuated the localisation of the shipbuilding industry upon the largest estuaries adjacent to the steel-producing regions. Only deep navigable waterways like the Tyne, the (improved) Clyde and Belfast Lough can cope with the giant ocean liners of to-day, and the cost of transporting the massive plates, angles, and machinery which are required for these vessels renders their erection far from the source of the materials an uneconomic proposition.

The great shipbuilding regions of the British Isles are five in number: (1) North-East Coast; (2) Clyde; (3) Belfast; (4) Birkenhead; (5) Barrow.

SHIPBUILDING: TONNAGE LAUNCHED [1] (Excluding Warships)
Gross Tonnage (Thousand Tons)

Area	1913	Average 1926–30	1931	1932	1933	1934	1935	1936
Clyde	685	460	148	62	49	238	161	282
Tyne	366	259	121	24	11	30	81	109
Wear	300	165	9	3	12	19	31	139
Tees	308	115	39	45	15	17	23	52
Belfast	129	118	78	6	14	87	97	63
Mersey	34	52	13	5	3	19	32	44
Dundee	18	25	25	1	7	1	5	26
Humber	49	19	7	2	8	10	9	23
Barrow	2	14	51	22	0	24	23	42
Leith	19	20	2	10	7	8	29	27
Other districts . .	22	15	9	8	7	7	8	49
Total	1,932	1,262	502	188	133	460	499	856

[1] Only vessels of 100 tons and over are included in these tables (*Lloyd's Register of Shipping*—annual summaries). 1937 total, 917; 1938 total, 1,018.

(1) *The North-East Coast Region* includes the lower Tyne, where the chief centres are South Shields, Newcastle, Hebburn, Wallsend, Jarrow, and Willington; the lower Wear, centred upon Sunderland; and the lower Tees and adjacent coast, where the principal centres are West Hartlepool, Middlesbrough, and Stockton. In this region some 40 firms are engaged in shipbuilding, and over 150 berths are available.[1] It has been estimated [2] that between one-sixth and one-seventh of the total employable population of Tyneside depends for its livelihood upon the shipbuilding industry. Although vessels of all kinds are built here, there has been a definite tendency to concentrate upon warships, small "tramp" steamers, and especially colliers,[3] and more recently oil tankers.[4] A notable exception, however, was the old "Mauretania," launched at Wallsend in 1907. The most famous firms on the Tyne are Swan Hunter & Wigham Richardson and Vickers-Armstrongs; from the yards of the latter the giant H.M.S. "Nelson" was launched in 1925.

The north-east coast region has declined slightly from the dominating position which it held thirty years ago. At the beginning of the century 50 per cent. of the British output of ships (or nearly one-third of the whole world's output) was being constructed here. Before the great depression of 1931–33 this percentage had fallen to between 40 and 45 per cent., and since then the proportion has been still lower (one-third or less). This is largely owing to the increase of the Clyde, which is now without any doubt the greatest shipbuilding region in the world. There has also been a certain amount of change within the north-east coast areas as regards the relative importance of the three rivers. The percentage of the total north-east coast tonnage launched by the areas named in 1900–03 was as follows [5]: Tyne 36, Wear 32, Tees 17, Hartlepools 15. The decline of the Tees estuary at the expense of the deeper and better equipped lower Tyne is indicated by the following percentages for 1927–30: Tyne 47, Wear 32, Tees 13, Hartlepools 9.

(2) *The Clyde* was never as important as the Tyne in the days of sailing ships. Its rise is more recent and really dates from 1812, when Bell's "Comet" was launched by John Wood at Port Glasgow. It was not an ideal waterway for shipping—at the end of the eighteenth century no boats drawing more than five feet could reach Glasgow; much of it is even now comparatively shallow, and only

[1] Berths available: Tyne (including Blyth) 83, Wear 37, Hartlepools 22, Tees 12. Total, 154 (1932).

[2] *Industrial Tyneside*, H. A. Mess. 1928.

[3] This is a heritage of the days of wooden ships, when the Tyne specialised in building colliers for the export of its "sea-cole" to London and elsewhere.

[4] Between 1924 and 1930 the north-east coast region built 60 per cent. of the tonnage of tankers launched in Britain. An additional speciality is floating docks.

[5] *Industrial Survey: North-east Coast Area*, p. 229.

by persistent dredging has it been improved and maintained.[1] Over 30 shipbuilding firms are situated along a 20-mile stretch of the river below Glasgow. These yards have a capacity of about one million tons of shipping per annum. A characteristic feature is the great variety of the work undertaken; but the speciality is perhaps the large passenger liner for transatlantic or other fast ocean services. The famous Cunarders "Aquitania" and "Lusitania," and more recently, the "Queen Mary" and "Queen Elizabeth," were built by John Brown & Co. of Clydebank. Naval construction is also important, and among the many ships of war turned out by Clydeside yards is H.M.S. "Hood," the largest battleship afloat. Of the many well-known firms the most famous are John Brown & Co., who did so much in co-operation with the Cunard Line to develop the turbine engine, Harland and Wolff, the Belfast company, owning some 300 acres of shipyards on the Clyde, William Denny of Dumbarton, builders of many cross-channel steamers, and the Fairfield Company of Govan. Their yards are probably the best equipped in the world, and are constantly being improved by the employment of labour-saving machinery.

The north-east coast and the Clyde together have been responsible, during the last ten years, for about 75 per cent. of the British output of ships. The other areas are much smaller, both in areal extent and in output.

(3) *Belfast.*—Although not backed by a great iron and steel producing region, the head of Belfast Lough, by the estuary of the Lagan, has remained an important shipbuilding centre by reason of the ease of import of the fuel and raw materials required. Both western Scotland and western Cumberland are capable of supplying Belfast with fuel and with steel, and the short sea journey involved does not add greatly to the cost of these materials. Belfast-built liners and cargo boats are to be found on most of the world's principal shipping routes. Messrs. Harland and Wolff own 220 acres of shipyards and engineering shops; many of the "White Star" liners have been launched from their yards, and Belfast engineers have materially aided the development of the Diesel engine for nautical purposes.

(4) *Birkenhead.*—At Tranmere, on the southern side of Birkenhead, are the large yards of Cammell, Laird & Co. The outstanding achievement of the firm in recent years is H.M.S. "Rodney" (launched 1925), a sister ship of the "Nelson" mentioned above.

(5) *Barrow.*—Shipbuilding was not important here until the local hæmatite ores came to be used in large quantities for steel-making. The first vessel was launched in 1873. The greater part of the industry is now under the control of Messrs. Vickers. Both naval and merchant vessels have been built, and in recent

[1] For 12 miles below Glasgow the Clyde is "as artificial as the Suez Canal." The annual expenditure upon dredging is about £60,000.

years Barrow has shared the pick of the new liner tonnage with the Clyde and Belfast,[1] but the speciality, for which no geographical reason can be given, is the construction of submarines. Most of the British submarines, other than those launched in the Royal Dockyards, have been built at Barrow.

A number of other ports have small shipbuilding industries, but the vessels constructed are mostly small. The Humber region offers a remarkable example of an industry carried on solely as the result of momentum gathered in past years. Always an important fishing centre, this estuary naturally developed the building of all kinds of fishing boats—and the ease of access, by canal and rail, to the Yorkshire coalfield, and by sea to the great iron and steel-works of the north-east coast, has resulted in a continuation of the industry. Beverley, on the river Hull, Selby on the Ouse, and to a smaller extent, Goole and Thorne, are engaged in assembling trawlers and drifters, for which various firms in Hull build the engines, and the Humber retains its position in the front rank of fishing craft construction centres.

Aberdeen, at the beginning of the last century, was the chief shipbuilding port in all Scotland, and later on in the 'fifties and 'sixties many famous "tea clippers" were launched from its yards for service between Britain and China. Subsequently, however, it has come to specialise in vessels for its own particular trade, *i.e.* trawlers, whalers, and other fishing craft.

Dundee, Leith, and Burntisland build cargo boats, and in the south of England, Southampton and Cowes specialise in yachts, motor boats, and the smaller types of naval craft.

The Thames deserves a little further comment.[2] For a long period London was one of the chief centres of British shipbuilding. The Blackwall yard, where the Orient Line had its origin, was founded in 1612, and a number of famous ships, including the "Warrior" (the first ironclad, built at Canning Town 1859), and the "Great Eastern" (built at Millwall 1855), have been launched from Thames-side yards. During the Victorian period some of the most prosperous firms in the country were located here; but the distance from supplies of fuel and steel has driven them all either out of business or to other localities, and all that remains is the extensive repair service (*vide infra*). The surprising thing is that the industry managed to overcome the economic difficulties involved in distance from the steel-works for so long a period: the battleship "Thunderer," the last big vessel to be launched, was only completed in 1911.

Attention must finally be called to the shipbuilding activities of the Royal Dockyards. Although a considerable proportion of

[1] In 1932 Barrow launched the only large vessel of the year—the 22,500-ton "Queen of Bermuda," and each of the years 1934, 1935, and 1936 has witnessed the launching of a liner of similar dimensions.

[2] See Aberconway, *op. cit.*, 326–329.

the naval requirements is ordered from public companies, a good deal of warship construction, amounting to nearly a half of the total, is carried out at Devonport, Chatham, and Portsmouth (see table below). All these places occupy heavily fortified situations where large expanses of tidal water are available for the "housing" of the British fleet. In many cases only the hulls of the new vessels are erected at the dockyard, the machinery being supplied by public firms of marine engineers.

United Kingdom Warship Building.[1] Vessels Launched
(Standard Displacement Tonnage) (Thousand Tons)

Area	1926	1927	1928	1929	1930	1931	1932
Clyde	11	21	21	7	1	2	—
Tyne	11	2	49	5	11	3	8
Barrow	3	—	6	8	1	—	4
Birkenhead	—	—	—	1	—	—	7
Southampton and Cowes	1	—	10	2	4	1	3
Portsmouth D.Y.	10	10	—	10	—	3	8
Devonport D.Y.	10	10	—	8	3	8	10
Chatham D.Y.	11	—	1	1	2	2	2
Total	57	43	88	43	24	19	41
Launched for foreign countries	1	22	11	7	4	2	2

[1] Compiled from lists of vessels in Jane's *Fighting Ships*.

Ship Repairing

In addition to the actual building of new ships, the repairing and overhauling of existing vessels is an industry of considerable importance. In its distribution, however, this industry differs considerably from shipbuilding. The chief necessity is a dry dock or some other means of raising the ship out of the water so that access to the hull may be obtained (see Fig. 199). It should be remembered, however, that many repairs may be effected without this preliminary procedure and that ordinary building yards may be used for repair work. Since it is obviously most economical to repair a ship on the termination of a voyage, during which the need for repair becomes apparent, the great ports of the country, as well as the shipbuilding areas, will share in the repairing industry; for the amount of material necessary to effect the repairs will not be large and may be of very diverse nature.

Whilst the Tyne, as judged by the number of dry docks, etc., in existence, dominates the industry, dealing with all classes of cargo boats, liners, and tankers, the ports of London, Southampton, and Liverpool have extensive facilities, largely controlled by the

great shipbuilding firms,[1] for the repair of the large liners and other vessels which visit them. The Clyde and Belfast are not nearly as important for repairing as for building—although more repairing is done on the Clyde than is suggested by Fig. 199, many building yards, when not engaged in new construction, being used for this type of work.

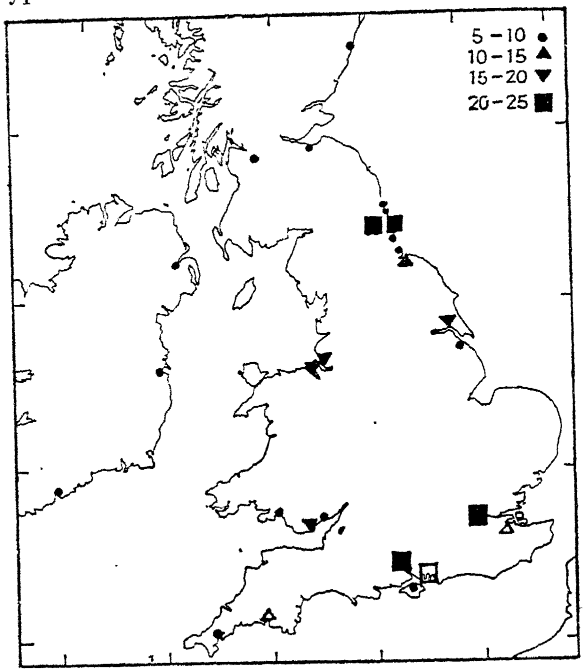

FIG. 199.—Facilities for ship-repairing in Britain—number of dry docks and slipways.
The symbols in outline are naval dockyards.

Marine Engineering

Although the chief new materials necessary for the shipbuilding industry are steel plates and angles, castings, forgings, tubes and pipes, *i.e.* the "heavy" products of the iron and steel works, numerous other items enter into the construction of a ship. A large amount of finished machinery such as winches and pumps is required, and large supplies of furnishing materials, joinery, paint, rope, and nautical instruments are also necessary. A large number of subsidiary industries are thus involved.[2] Chief of these, however,

[1] Harland and Wolff, for example, own extensive yards at Liverpool and Southampton and control the repair yards of the Port of London Authority.

[2] In 1930 (Census of Production) "ships' and boats' fittings" to the value of £44 million were employed—a sum not far short of the value of all the new construction and repair work done during the same year (£56 million).

is marine engineering—the construction of the boilers, turbines, and driving gear for all kinds of vessels. The marine engineering industry, dealing as it does in very bulky, though valuable, pieces of machinery, must of necessity be located in close proximity to the shipyards. In many cases the shipbuilders control their own marine engineering works; and some of them even control the output of the steel which they employ. The chief centres of the industry are the Clyde, the world's greatest producer, where 24 firms, including

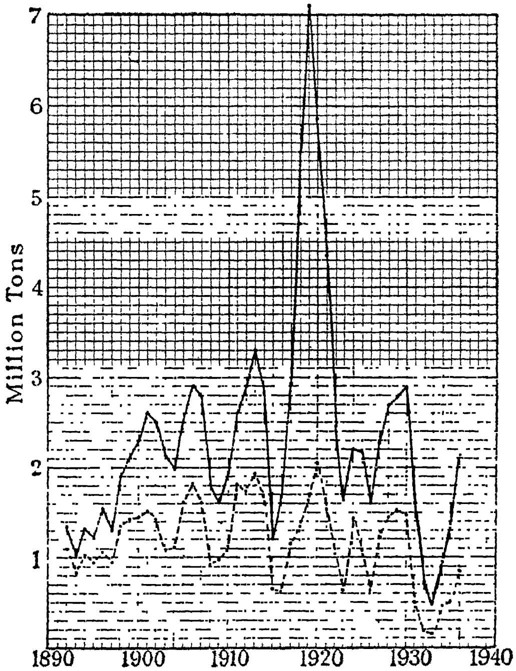

FIG. 200.—Shipbuilding as a trade barometer.

Graph showing tonnage launched (excluding warships and sailing vessels) in the world (solid line) and Britain (dotted line).

such famous names as Yarrow and Fairfield, are engaged, and the north-east coast, where the most important firm, independent of the shipbuilding companies, is Parsons Marine Steam Turbine Co., on the Tyne.

The shipbuilding industry is often described as a "trade barometer" (see Fig. 200), as it reflects, perhaps more faithfully than any other trade, the general state of the world's commercial activity. At the same time it is the key to the prosperity, or otherwise, of a large number of subsidiary industries. Probably a third of the steel produced in Britain formerly went towards the building of ships,

and, as we have just indicated, so many other trades are involved that even a small slackening of the demand for new ships is immediately followed by a depression, the repercussions of which are felt throughout the country. The shipyards suffer most, however. The iron and steel works may have other products, such as boiler plates, girders, and rails, to which they can turn their attention, and the engineering shops may obtain orders for other types of machinery, but a shipyard must build ships or nothing.

[*Photo : L. D. Stamp.*

FIG. 201.—Merchant shipping.

When this photograph of Gare Loch (Scotlan[illegible] 1932, there were over forty vessels of between 3,000 and 8,000 tons [illegible] as a result of the world depression.

The world-wide depression in shipbuilding which characterised the years 1931–33 was due to four main causes :

(1) The over-production of ships during the boom period which followed the four destructive years of the War.

(2) The general world depression of trade which reduced the demand for shipping of every kind.

(3) The Washington Agreement, under which the building of warships was severely curtailed.

(4) The alteration by the Board of Trade, during the War, of the Plimsoll Line regulations, which allowed ships to carry a greater load, and increased the carrying capacity of the world's ships by probably a million tons.[1]

All these factors combined to depress the shipbuilding industry to an unprecedented extent. In 1931, some 12 million tons of

[1] Aberconway, *op. cit.*, 174.

shipping, or 17 per cent. of the world's total, was laid up without employment [1]; $3\frac{1}{4}$ million tons were laid up in ports of the United Kingdom alone. It is little wonder, then, that over half of the 200,000 people normally employed in the shipbuilding industry were unemployed, and that many of the older shipyards were being closed down.[2]

WORLD'S SHIPBUILDING (Excluding Warships)
(Thousand Tons)

Country	1913	1919	1920	Average 1921–25	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936
United Kingdom	1,932	1,620	2,056	1,148	639	1,226	1,446	1,523	1,478	502	188	133	460	499	856
Germany . . .	465	*	*	392	180	289	376	249	245	104	81	42	74	226	380
France . . .	176	32	93	129	121	44	81	81	101	103	89	34	16	43	39
Holland . . .	104	137	183	121	94	120	167	186	153	120	26	36	47	57	94
Italy	40	83	133	112	220	101	59	71	87	165	47	17	27	23	11
U.S.A. . . .	276	4,075	2,576	315	150	179	91	126	247	206	144	11	25	33	101
Japan	64	612	457	102	52	42	104	164	151	83	54	74	152	146	295
Other countries .	265	585	363	262	218	284	375	383	427	334	98	141	166	275	452
Total . . .	3,332	7,144	5,861	2,581	1,674	2,285	2,699	2,793	2,889	1,617	727	489	967	1,302	2,118
Per cent. by U.K.	58	23	35	46	38	54	54	54	51	31	26	27	47	38	40

* Figures not available.

The spread of the shipbuilding industry in those countries which were less affected by the 1914–18 War (*e.g.* Japan, the United States, Holland, and Sweden) has considerably increased the world's capacity for launching new ships, and the proportion of the world's tonnage constructed in Britain has consequently declined. The position lost during the War was regained, however, during the period 1927–30, but the onset of a further period of intense depression was followed by a decline in the relative importance of Britain to 30 per cent. This is a disturbing situation, for in order to maintain her economic position in the world's commerce, and to ensure the prosperity of her heavy industries, Britain's supremacy in shipbuilding must be retained at all costs. As on previous occasions, however—and this time partly helped by the Government's "scrap and build" plans and the tramp shipping subsidy—Britain has emerged from the depression quicker than most countries, as the table above shows.

Engineering [3]

The geographical principles underlying the distribution of the engineering industries have already been touched upon (p. 374).

[1] Report of United Kingdom Chambers of Shipping, February, 1932.

[2] During 1930, for example, shipyards at the following localities involving seventy-one berths were bought up and closed by the National Shipbuilders Security, Ltd.: Dalmuir, Old Kilpatrick, Ardrossan, Lowestoft, Stockton, Middlesbrough, Whitby, Sunderland, South Shields, Hebburn, and Howden. (Report of United Kingdom Chambers of Shipping, February, 1931.) By September, 1935, 149 yards had been bought up, and the process continues slowly.

[3] The term "engineering" is here used in a very wide sense, and is intended to cover not only engineering proper, *i.e.* the manufacture of engines and other machinery, but the whole range of products of which iron and steel form the basis.

It is probably true to say that there are few towns of any size in the country which have not either a foundry or some small factory making use of iron and steel.[1] This being so, a rough classification of the engineering towns is necessary in order that we may better comprehend the distribution of the industry. Engineering towns in Britain may be divided into two distinct types :

(*a*) Those in which the engineering industry is preserved by reason of the local supplies of coal and iron ; *e.g.* the towns of the coalfields. The particular branch of engineering involved will depend primarily upon various local factors which we shall examine in detail later ;

(*b*) Towns not situated on, or quite close to, the major coalfields and iron-producing centres. These towns may be further subdivided into two classes :

(*i.*) Those in which the presence of the engineering industry is due to some definite local demand for certain types of iron products. Under this heading come most of the engineering centres of eastern England, where the manufacture of agricultural implements is of quite early origin.

(*ii.*) Those in which the engineering industry is of much more recent growth and is due either to the situation of the town with regard to railways—as, for example, the locomotive building towns of Swindon and Ashford (Kent)—or to the presence of large and increasing agglomerations of population which can be drawn upon as a source of labour supply, *e.g.* Letchworth (Herts), Luton, and Slough.

This classification cannot be regarded as comprehensive or exhaustive, but it may serve as a guide in our study of the engineering industry of Britain. The chief engineering provinces are seven in number. They may be briefly summarised as follows :

(1) *Manchester and South Lancashire.*—Textile machinery, constructional engineering, engines and locomotives, and electrical apparatus.

(2) *Yorkshire, Nottinghamshire and Derbyshire Coalfield.*—Textile machinery (West Riding), heavy engineering, locomotives ; the special trades of Sheffield and the miscellaneous industries of Derbyshire and Nottinghamshire.

(3) *The North-east Coast.*—Marine engineering (*vide supra*), constructional engineering and rails, locomotives.

(4) *The Scottish Lowlands.*—Marine engineering (*vide supra*), constructional engineering, heavy machinery, locomotives.

(5) *The Black Country and Birmingham.*—Heavy foundry and forge work, constructional engineering, miscellaneous trades of Birmingham.

(6) *The Smaller Midland Coalfields.*—Miscellaneous industries of North Staffordshire and Warwickshire.

(7) *South-eastern Great Britain.*—Scattered miscellaneous machinery industries and foundry products, especially agricultural and excavating machinery and locomotives.

[1] There are about 2,400 foundries in Britain ; they absorb nearly 20 per cent. of the output of pig-iron.

Before we consider these provinces in greater detail certain rather specialised industries call for individual comment.

The manufacture of *textile machinery*, which gave employment to nearly 50,000 people in 1930, is dominant, as one would expect, in the great textile working regions of south-east Lancashire and the West Riding (see Fig. 202), the only other centres of any importance lying within the regions of minor specialised textile production (*vide infra*). In the census of 1931 about two-thirds of the workers employed in the industry were in South Lancashire and just under one-third in the West Riding. The industry has

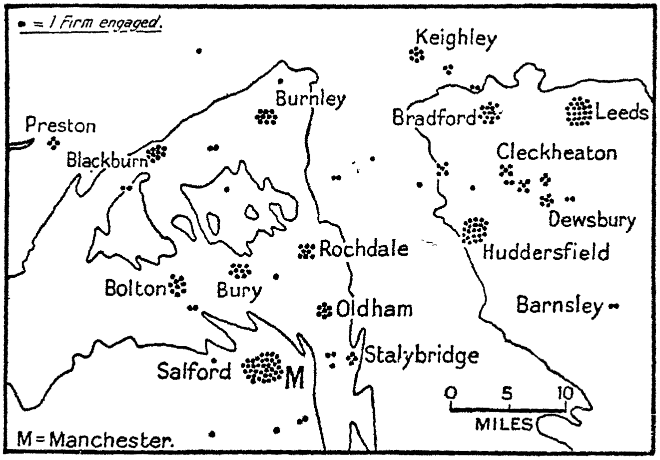

FIG. 202.—The textile-engineering industry of Lancashire and Yorkshire. Lines show boundaries of exposed Coal Measures.

been located here on both sides of the southern Pennines ever since the first machines for working cotton and wool were invented (*i.e.* since the end of the eighteenth century), and the growth of the textile industries, together with the presence of coal and the proximity of the iron and steel districts of Yorkshire and the Midlands, have given it such a momentum that it easily retains the premier position which it has always held, supplying not only the local manufacturers, but also, until comparatively recently, most of the other textile industries of the world. The map shows that nearly every important town in the textile-manufacturing area of Lancashire and Yorkshire has one or more factories engaged in producing machinery for working cotton, wool or artificial silk. Although the Lancashire towns confine themselves mainly to cotton-manufacturing machinery, and the West Riding towns to woollen and worsted machinery, a few firms in the towns where the two regions approach most closely (*e.g.* Huddersfield, Keighley, Rochdale, and Oldham) produce machinery for both industries; and

firms making artificial silk machinery are to be found in both regions. Some of the larger firms turn out practically every machine which is used in the textile industries; others specialise in certain types of machine, or machines for special processes. The manufacture of machinery used in bleaching and dyeing, for example, is concentrated especially in the bleaching region of South-east Lancashire (Manchester and Bury) and in Huddersfield. Looms are made chiefly in the Lancashire weaving regions at Burnley and Blackburn, and in the West Riding at Bradford. It is impossible to give details, but two of the largest firms are deserving of special mention. Platt's of Oldham are the largest textile machinery factors in the world. Normally employing 11,000 people, they make all kinds of textile machinery, and in addition control their own machine-tool works, and are owners of collieries and coke ovens. Dobson and Barlow of Bolton, established in 1790, claim to be the oldest firm of textile engineers in the world. They employ some 5,000 workers, and are also in control of their own engine and tool factories.

The most important Lancashire centres of the industry are Manchester-Salford, Oldham, Bolton, Rochdale, Blackburn, Burnley, and Preston. On the Yorkshire side Leeds and Huddersfield dominate the industry, but Bradford and Keighley are also important, together with Halifax and a group of small towns lying between Dewsbury and Cleckheaton.

Much damage has been done to the cotton section of this industry by the widespread depression of the cotton trades in all parts of the world—a consequence of overproduction. Great prosperity was enjoyed in Lancashire while the factories were building machinery for the growing cotton industries of Japan, China, and India, but the excess of productive capacity now existing means that little new machinery is being required.[1] Foreign firms have even been buying second-hand machinery from Lancashire's closed mills. On the other hand, the growth of the artificial silk industry has created a demand for new types of textile machinery.

Of the other localities where textile machinery is made, the chief are Nottingham and Leicester, which between them share the bulk of the trade in hosiery machinery. Nottingham, in addition, is supreme in the manufacture of lace-making machinery. Macclesfield occupies a similar position with regard to silk machinery; and Dundee makes most of the machinery used in the jute and hemp trades. A few other scattered centres in Scotland make various kinds of textile machinery; *e.g.* Hawick and Galashiels (woollen), Paisley, and Glasgow (cotton). Belfast supplies machinery to the Irish linen industry. Much of the produce of the textile machinery industry, as suggested above, is destined for export.

[1] In the textile-machinery industry as a whole employment has declined from 70,000 in 1921 to 60,000 in 1924, and 48,000 at the Census of Production in 1930.

EXPORTS OF TEXTILE MACHINERY
(Thousand Tons)

Country	1913	Average 1921–25	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935
U.S.S.R. . . .	15·3	0·6	15·2	10·0	9 9	7 0	8·2	1·4	0·8	0·2	0·1	0·3
France	12·6	12·2	6·5	5·0	6·7	7·5	8·0	3·9	1·3	0·9	1·2	1·8
Belgium . . .	10 3	5·8	6 2	7·1	7·1	7 5	4·4	2·5	1·9	1·6	1·9	1·6
Germany . . .	13·9	2·7	3·9	9·4	10·5	5·1	2·7	1·5	1·1	1·6	1·9	1·2
Italy	2·4	4·1	4·1	2·0	4·7	4·3	2·4	0·8	1·3	1·3	1·7	1·1
China	3·3	9·4	1·9	2·8	2·9	10·6	10·5	5·8	7·5	2·5	4·7	2·7
Japan	19·7	15 0	6·9	8·1	11·6	14 4	5·3	2·9	3·4	1 0	2·1	2·0
India	50·3	49·1	23·0	24·5	35·6	38·2	30·6	21·9	27·5	24·9	28·7	28·0
Brazil	11·9	8·2	8·1	6·3	4·6	3·3	1·3	1·4	1·3	1·9	2·3	1·6
Other countries .	38 3	28·3	25 6	44·0	31·8	78·6	17·9	13·5	15·9	20·6	32·9	25·4
Total	178·1	135·4	101·5	119·3	125 2	126·5	91·2	55·6	62·0	56·5	77·5	65·7

The table shows that in no post-War year has the total reached the 1913 figure. The actual amounts exported to individual countries may fluctuate considerably from year to year—but it is still true that India is by far our best customer, whilst the Far Eastern countries and our near European neighbours can still be relied upon to take considerable quantities.

The *Locomotive-building Industry* of Britain, although of long standing (some of the firms are nearly 100 years old), is distributed in an extraordinary fashion. Two factors contribute to this. First, locomotives can run on wheels under their own power, and so do not have to be built in the locality in which they are to work. This means that while we shall expect, by reason of the bulk of the raw materials required, that the industry will be primarily located in those areas where iron and steel are produced, it will not surprise us to find building centres in places remote from such regions where other local factors may have given rise to the industry. Secondly, it has always been the policy of the principal British railways (and in this respect they are almost unique in the world) to build most of their own engines and not to place extensive orders with public engineering companies. This has resulted in the setting up of a locomotive industry in a number of places where, despite the distance from the raw materials, the railway companies concerned considered that the nodality of the site with regard to their particular system warranted the establishment of the works. Of the sixteen engineering companies which build locomotives, all but five are noticeably grouped about four nodes, each of which is in the heart of one of the engineering provinces, based upon the coalfields, which we have already mentioned (Fig. 203). The Glasgow-Kilmarnock area has four large works, three of which belong to the North British Locomotive Co., which is the largest concern of its kind in Europe. Two works are situated on Tyneside and three, of which the largest is that of Beyer, Peacock & Co., in the neighbourhood of Manchester. Another group of four

have their headquarters in Leeds. The remaining works are situated at Darlington, Sheffield, Stafford, and two at Bristol. With the exception of the Bristol works, both of which build locomotives mainly for industrial purposes (works, docks, etc.) and not for ordinary railways, all these locomotive-building establishments are essential components of that great engineering

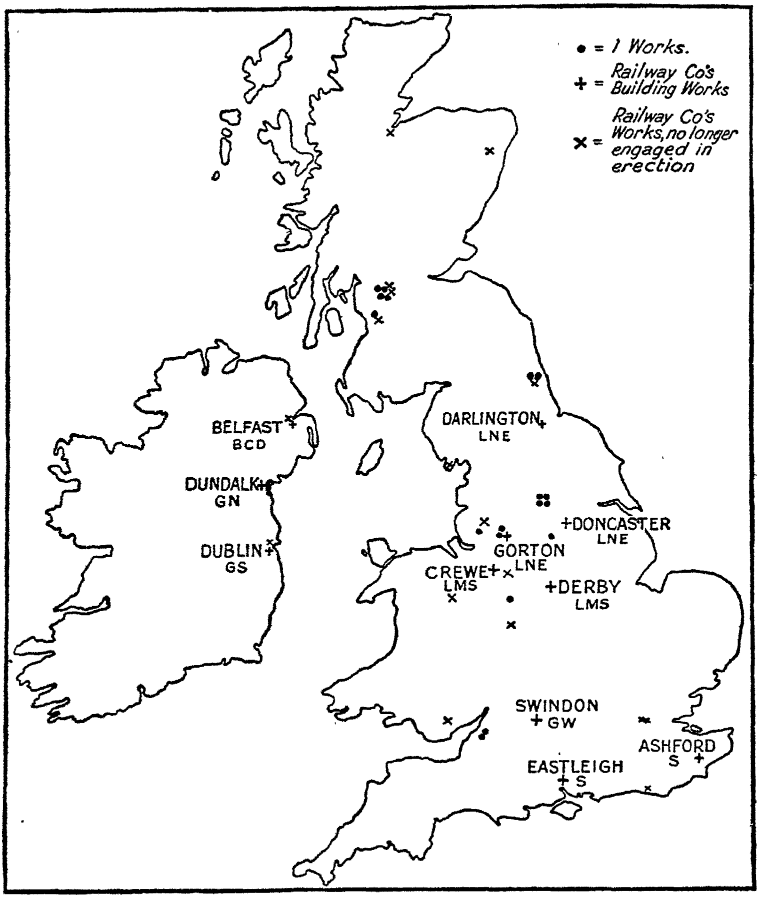

FIG. 203.—Map showing locomotive-building centres.

industry of Britain which owes its development to the proximity of iron and coal. Many of the works belonging to the railway companies, on the other hand, are situated at some distance from coal and iron, and the only explanation of their location is that they occupy nodal points on the railway system to which they belong. Such are Crewe, Swindon, Oswestry, Eastleigh, Brighton, Ashford,

and Stratford.[1] The works of the railways which serve the industrial north, however, are naturally situated near to their sources of raw materials, as Doncaster, Derby, Darlington, Gorton, Horwich, Kilmarnock, and St. Rollox (Glasgow). The Irish centres, Dublin, Belfast, and Dundalk, are all ports on the east coast where the raw materials and fuel are most easily obtainable across the Irish Sea from England and Scotland.

After the amalgamation of the principal lines into four groups in 1923, the building of locomotives at many of the smaller and less well equipped works, *e.g.* Oswestry, Stoke, Barrow, Kilmarnock, Gateshead, and Cowlairs (Glasgow), was abandoned, their activities being confined to the execution of repairs; and subsequently the process of rationalisation has still further reduced the number of works engaged in building, Brighton, Horwich, St. Rollox, and Stratford having also ceased. As a result of this the remaining works are incapable, especially during the periods when heavy renewals are in progress, of turning out all the requirements. All the groups during the past decade have found it necessary to call upon public engineering companies for many new engines.[2]

EXPORT OF STEAM LOCOMOTIVES

(Tons)

Destination	1913	Average 1921–25	Average 1926–30	1931	1932	1933	1934	1935
Netherlands	1,144	—	—	—	—	—	—	—
Spain	526	—	—	—	—	—	—	—
Argentina	11,571	2,686	7,814	4,954	9	95	58	91
Brazil	1,279	158	1,079	233	—	—	345	176
Chile	1,179	276	599	—	—	—	—	—
Egypt	224	—	2,254	—	27	83	39	693
India and Ceylon	14,810	16,622	14,037	9,719	672	2,847	1,085	1,421
Australia	5,287	511	1,552	—	4	4	43	89
S. Africa	3,878	2,382	1,868	298	62	90	1,721	3,611
British W. Africa	635	1,533	1,047	204	501	17	24	290
British E. Africa	1,094	825	1,338	1,470	—	5	35	11
Others	5,494	8,799	6,917	2,452	1,208	5,138	1,078	3,793
Total	47,121	33,461	38,495	19,330	3,483	8,279	4,528	10,175
Number of locomotives	?	662	681	328	169	478	398	446

During the five years 1927–31 the British railways constructed in their own shops upwards of 1,800 locomotives, and during the same period they acquired over 700 from other engineering works. Before 1914 the engineering companies were building

[1] The railway-created towns, Crewe and Swindon, will be more fully referred to in Chapter XXVII. See pp. 590–91.

[2] The Southern Railway has had least occasion to obtain outside assistance. the reason being that, as it is the smallest of the groups and has no great industrial districts within its system, it does not need the large numbers of small shunting and heavy goods engines such as the G.W. and L.M.S. companies, for example, have built or purchased in recent years.

over 1,100 locomotives every year. At the end of the War, after the demands made by the Ministry of Munitions, their capacity had risen to over 1,800 a year. Since that time, however, their trade has fallen off considerably owing to the world economic depression, and the welcome revival of 1928–30 was short lived. The year 1932 saw the export trade almost at a standstill.

Apart from the general depression, however, many of our markets have been lost by the setting up of locomotive-building industries in the countries to which we formerly exported in large numbers.[1] Of recent years the best markets have been India, Argentina, and the British territories in Africa.

The *Motor Industry* [2] is of much more recent growth. Daimler built his first car at Coventry in 1896. By 1907 the industry claimed 53,000 employees; and in 1931 over 190,000 people were engaged in the construction of motor vehicles; whilst indirectly at least another million are probably concerned in the trade. The output rose rapidly from 95,000 vehicles in 1923 to 236,500 in 1930 and 416,900 in 1935, in which year the industry was the fourth largest in the country by value of output (or fifth by employment), and the United Kingdom was the world's second largest producer. Whilst most towns now have a repair works of some kind, the building industry is more definitely localised in a few important regions—the Birmingham and Black Country district (which in 1931 claimed 40 per cent. of the workers), Greater London (which had 14 per cent.), and south Lancashire (with 10 per cent.). The industry is divided into three branches—private cars, commercial vehicles, and motor cycles. The geographical influences to be borne in mind are these:

(1) A very wide range of industrial products is necessary for the building of motor cars. Of the iron and steel products, castings, drop-forgings, sheet metal, tubes, and wire may be mentioned [3] but a large number of other raw materials are required—woodwork, rubber for tyres, leather, glass, and much copper, brass, and aluminium.

(2) Most of the work is skilled, hence a large labour supply already used to mechanical engineering is required.

(3) The raw materials are so diverse and the final products, which can be transported under their own power, so valuable, that the location of raw-material supplies exercises little, if any, control over the location of the industry.

[1] In 1913, for example, upwards of 100 engines were exported to Australia; in 1930 nine small works engines only.

[2] See G. C. Allen: *British Motor Industry.* London and Cambridge Economic Service. Special mem. No. 18. 1926. *Idem, British Industries*, Chapter VII. Longmans, Green & Co., 1933. *Survey of the Trade in Motor Vehicles.* Rept. Imp. Econ. Cttee. H.M.S.O. 1936.

[3] One Birmingham factory uses 500 tons of steel sheets and 120 *miles* of steel strip per week.

At Coventry, and to a less extent at Birmingham and Wolverhampton, the motor industry has developed out of an existing cycle industry, and its great progress in this area is essentially due to the great variety of trades already flourishing in the west Midlands, and to the huge "deposit" of labour well skilled in the multifarious engineering trades of Birmingham and its neighbourhood. Most of the iron and steel work required is made within the region (much of it from special Sheffield steels) and the Birmingham area is chief in the country for non-ferrous metals. Although each of the three big towns has all branches of the industry represented, Coventry is the chief centre for engine building, Wolverhampton for motor cycles, and Birmingham for commercial vehicles (Morris Commercial Motors, Ltd., at Smethwick).

In the London area the presence of a huge population, the existence of numerous other engineering trades and the great demand for vehicles have contributed towards the rise of the motor industry. The Associated Equipment Co., which builds London's buses, is the chief establishment, whilst the new Ford works is situated on Thames-side at Dagenham.

In south Lancashire, where the industry is centred upon Manchester, the controls are similar—the presence of an engineering industry and a large skilled labour supply.

Of the outlying centres of the industry, Oxford easily leads. Here, at Cowley, from small beginnings the enormous business of Viscount Nuffield has been built up—an organisation which, capable of turning out 50,000 cars a year, has done much towards driving small foreign cars from British roads. Other notable centres are Derby (the home of the Rolls-Royce), Bristol, Huddersfield, Nottingham, and Luton.

Having obtained a secure position in the home market—94 per cent. of the cars sold in Britain are home produced—manufacturers are turning their attention more and more to the export trade, most of which is at present done with the Empire (70 per cent. of the total in 1935). In 1935 48,000 private cars were shipped abroad, 2,400 commercial vehicles and 22,000 chassis.[1]

Heavy Electrical Engineering and Cables.—With the development of domestic electricity and wireless the smaller electrical trades have expanded rapidly and have spread over many parts of the country; for the produce is for the most part small and valuable, and the manufacture can be carried on almost anywhere, the site depending more on the availability of labour than

[1] The cycle trade has expanded at the same time as the motor industry: there are over 10,000,000 cycles in use in Britain, and a large export, notably to Africa. A later industry of great importance, allied to the motor industry is the making of aeroplane engines and the building of aeroplanes. This is mainly attached to the engineering towns already mentioned, but in some cases waterside situations have been chosen, to permit the testing of flying boats, *e.g.* at Rochester and Southampton.

upon railway facilities or location with reference to raw material supplies.[1]

The heavy electrical trades, however (*i.e.* the construction of electrical machinery and power-producing plant), are more definitely localised, and their rapid development in the last twenty years has been one of the principal features of post-1918 industry in Britain. In 1931 some 242,000 people were employed in the electrical trades of Great Britain, about 67,000 being engaged in the production of electrical machinery, wires, and cables. In almost every case, the only important exception being Rugby, the industry is located in towns and cities where a flourishing machinery industry of one kind or another already existed; railway facilities have also played a part, for adequate means of transport are essential to an industry which imports much of its raw material (copper, mica, etc., from abroad, and heavy steel castings, probably from Sheffield), and produces bulky and valuable goods. The metropolis of the industry is at Manchester, the home of the Metropolitan-Vickers Co., which, normally employing about 12,000 people, produces power plant and electric locomotives of all kinds. At Rugby, the forerunners of the British Electric Co. set up their works in 1897, and a huge industry, increased by the advent of the British Thomson-Houston Co. in 1901, has resulted. Heavy machinery and turbo-electric plant are made here. These are the principal centres. Others of less importance are Coventry (radio apparatus and other plant), Preston (electric motors, locomotives, and tramcars), Birmingham (electric motors and other plant), Hebburn-on-Tyne (switchgear), and Loughborough (turbo-electric motors and railway equipment).

EXPORTS OF ELECTRICAL MACHINERY
(Thousand Tons)

Countries	1913	Average 1921–25	Average 1926–30	1931	1932	1933	1934	1935
U.S.S.R.	0·7	0·4	1·5	2·5	5·8	2·2	0·2	—
Netherlands	—	0·1	0·7	1·8	0·1	—	—	0·2
China	0·3	0·7	0·6	0·9	0·9	0·4	1·0	0·6
Japan	2·9	0·8	1·3	0·2	—	—	—	0·1
India	3·6	5·1	7·8	4·3	5·4	3·4	4·6	4·8
S. Africa	1·6	2·6	4·2	2·4	3·2	4·4	7·6	10·1
Australia	3·3	4·5	6·0	0·9	0·8	1·2	1·4	1·9
New Zealand	0·8	1·5	2·4	1·2	0·6	0·5	0·5	1·0
Canada	2·0	0·4	2·0	2·0	1·0	0·3	0·5	0·5
Argentina	2·9	0·6	1·9	1·4	0·4	0·3	0·2	0·3
Brazil	1·3	0·7	0·9	0·2	0·3	0·2	0·3	0·6
Other countries	7·4	6·7	10·2	9·3	14·0	4·7	6·1	8·1
Total	26·9	24·1	39·5	27·2	24·5	17·6	22·4	28·2

Cables.—The manufacture of cables and wiring for the transmission of electrical energy—an industry which represents probably

[1] Many new works manufacturing electrical instruments and apparatus are springing up, for example, alongside the new arterial roads on the outskirts of London.

a half of the total capital invested in electrical concerns in Britain, and which employs some 33,000 people,[1] is deserving of special mention. As an industry it represents a link between heavy electrical machinery and the non-ferrous metal trades (see Chapter XIX). A moment's reflection upon the multiplicity of the uses of electric cables—for house wiring, post office and other telephones, railway signalling, power transmission, and submarine telegraphs—is sufficient to establish its importance in modern life.

Like the motor industry the manufacture of cables employs a great variety of raw materials : copper, aluminium, and steel wires, insulating materials in the form of rubber, oiled paper, and cambric, lead for sheathing, jute to form part of the protective covering, and timber for the rollers upon which the finished products are mounted for transport. Many of these items must be imported, and a large part of the produce is destined for export, so that we shall expect to find the industry located near the large ports, especially in the vicinity of the non-ferrous metal industry (cf. Chapter XIX). The banks of the Thames below London—as at Erith, Barking, and Northfleet—support perhaps a half of the total industry, whilst a considerable proportion of the remainder is localised in the important non-ferrous metal district of south Lancashire, at Manchester, Prescot, and Liverpool ; Glasgow is the centre of the trade in Scotland.

The cable industry is one of those few industries which did not suffer severely from the economic depression of the years 1931–34, the progress of the grid scheme of the Central Electricity Board having provided it with an immense home market for overhead and underground cables.

Engineering Provinces

We may now comment briefly upon the various engineering provinces mentioned above, noticing the geographical factors which have helped to influence their development and the present-day trends of their industries. (See Table on p. 410.)

(1) *Manchester and South Lancashire.*—Manchester is the hub of one of the world's greatest engineering districts. In 1931 some 217,000 people in Lancashire and the adjoining part of Cheshire were employed in the various branches of the engineering industry, about 22,000 being engaged in the textile-machinery industry alone. Yet south Lancashire is not, and never has been, a great iron and steel-producing area. As we have seen (p. 332) the coalfield was devoid of Coal Measure ironstones so that no great smelting

[1] Estimate from Cable Manufacturers' Association, 1932.

rails in Britain have been rolled at Leeds),[1] machine tools, drilling and boring machinery, hydraulic apparatus and certain types of constructional steelwork (*e.g.* gasholders). All these trades employ iron and steel from Middlesbrough, Scunthorpe, and Sheffield.

(*b*) *South Yorkshire.*—The unique industries of Sheffield (cf. Chapter XVII, p. 364) are divisible into two groups: (*a*) cutlery and small articles, *e.g.* hand tools, clock springs, and pen nibs; (*b*) the heavy steel trades. The latter include huge castings and forgings for ships and heavy machinery, armour plating, guns, and certain types of railway, tramway, and electrical apparatus where special hardness, strength or magnetic properties are required. Some of the names in the Sheffield steel industry are world famous: Firth's (stainless steel), Vickers (the Manchester electrical engineers and Barrow shipbuilders), Cammell Laird (the Birkenhead shipbuilders), John Brown (the Clyde shipbuilders) and Hadfield's (the pioneers of manganese steel) are amongst the best known.

Rotherham takes part in two types of Yorkshire industry, the special steel manufacture of Sheffield, and the wrought and cast iron trade which developed on the coalfield in the early days of iron smelting. Like Sheffield, it makes, at the Park Gate and other works, special steels and their products—heavy castings and forgings for marine engines and other machinery. Side by side with this have developed the railway rolling stock and constructional steelwork trades. Very different, and much older, however, are the wrought-iron industry and the manufacture of stoves and grates.[2]

(*c*) *Derbyshire and Nottinghamshire.*—The industries of this group, whilst owing their origin to the presence of coal and iron, are more allied by their miscellaneous character to the scattered engineering trades of south-eastern Britain. It is probably due to the towns themselves not forming a coherent whole, and to the absence of any vast industrial occupation, such as textiles or shipbuilding, which could generate a machinery industry. Typical of the area (apart from the locomotives and hosiery machinery already referred to) are the chains, castings, and refrigerating machinery of Derby, the cycles of Nottingham, and also cast-iron pipes and iron and steel grates.

(3) *The North-East Coast.*—The two characteristic engineering industries of this region are the building of marine and locomotive engines, located principally on Tyneside, and the production of ship plates, rails, and constructional steelwork, centred upon Teesmouth.

[1] Aberconway, *op. cit.*, 94.

[2] It is interesting to recall that the plates for the "Great Eastern" were rolled at Rotherham (cf. p. 388).

Marine engineering is a natural accompaniment of shipbuilding, and locomotive building is a kindred industry which here, as on the Clyde, has assumed large proportions (cf. pp. 391 and 397). The constructional steelwork (girders for bridges and buildings) produced by Dorman Long and other famous bridge builders of Teesmouth is a peculiarity the origin of which is less obvious. There are two factors to be borne in mind :

(a) The iron industry of Teesmouth began much later than those of the coalfields, in an area where there was no previous industrial development and no existing machinery industries.

(b) The coastal site favoured the growth of an industry which specialised in bulky, unwieldy products for which a large market existed abroad. Thus the heavy machinery industries never developed, and the principal products, apart from the export of iron and steel to other areas, have been shipbuilding steelwork, rails, and girders. Recent triumphs of Teesmouth are the steelwork of Sydney Harbour Bridge and of the Little Belt Bridge in Denmark.

(4) *The Scottish Lowlands.*—The western portion of the Scottish lowlands, centring on Glasgow, but extending north-east to Falkirk and south-west to Kilmarnock, is a great engineering province for three reasons :

(1) There are excellent facilities for the production of iron and steel from local and imported materials.

(2) For a period in the 'thirties and 'forties of last century central Scotland was the most important iron-producing region in Britain, and consequently was a centre of attraction for many engineering industries.

(3) The shipbuilding industry naturally gave rise to a marine engineering industry, and the skill acquired in this branch could easily be applied to other branches of engineering.

The region thus partakes of the characteristics of both Manchester and Tyneside. In 1930 about 90,000 people were employed in the engineering trades.[1] The great marine-engineering industry of the Clyde, employing 20,000 people, has already been dealt with, and we have seen that Glasgow is the most important locomotive-building centre in the British Isles. The textile-machinery industry is present, though it bears no comparison with that of South Lancashire. One firm at Clydebank, however, employs 10,000 people in the manufacture of sewing machines. As a natural accompaniment to locomotive building we have boiler making (*e.g.* Babcock and Wilcox), and the production of stationary steam engines and pumps. These trades, together with marine-engineering, have given rise to an extensive manufacture of

[1] *Industrial Survey of South-west Scotland*, p. 63.

machine tools, in which branch the Glasgow district seriously rivals the Manchester area. Glasgow leads the world in the production of machine-tools for the building of marine engines; and it is the chief centre in Britain for the production of mining equipment, such as coal-cutting machinery. Constructional engineering is another natural outlet for the steel of a seaboard region; and among the many firms engaged in this branch the most famous is that of Arrol & Co., the builders of the Forth, Tay, and Tower bridges. Other characteristic products of this province are steel tubes, hydraulic engineering machinery, sugar-making machinery (a result of Glasgow's former important trade with the West Indies), and various types of cast-iron articles such as stoves and grates, for which the Carron company, for example, is specially noted.

(5) *The Black Country and Birmingham.*—The Black Country is the oldest of the great engineering provinces, and the origin of its iron and steel industry has already been discussed (Chapter XVII, p. 361). Even in the sixteenth century the manufacture of nails, knives, and locks was going on in the area,[1] and the momentum given by this early start, by the fortunate occurrence in juxtaposition of the raw materials of the iron industry, and by the steam-engine trade of Boulton and Watt in the last 20 years of the eighteenth century, enabled a vast engineering industry to be built up. Birmingham, not on the coalfield, quickly began to specialise in small valuable articles, whilst the heavier industries concentrated in the Black Country. The interior position of the region and its nodality within the country meant that all districts could be equally well served, whilst shipbuilding and marine engineering and the heaviest branches of the steel industry could not be expected to develop. As a result the dominant note of the engineering industry became *variety*. The decline of iron smelting has been accompanied by an even greater specialisation in all kinds of engineering industries based upon local steel produced from non-local ores and pig-iron. The localisation of many of these industries is not geographically explicable, being often almost accidental and due to the chance decision of a manufacturer of certain goods to set up his factory in a particular spot. In no other way can the tubes of Wednesbury, or the coil springs of West Bromwich, be explained.

Only the outstanding products can here be indicated. The list is so extensive that any enumeration must omit many important ones. Amongst the principal *groups* of products, however, the smaller usually included under the term "hardware," the following seem to be characteristic: chains and locks; nuts, bolts, and screws; steel tubes; iron castings of every description; stoves, grates, and fireirons (and their modern developments, gas and electric fires); constructional steelwork; railway rolling stock; and many kinds

[1] Leland's *Itinerary*, Vol. IV, fol. 186.

of steam and other engines and machinery. The iron hollow-ware (now frequently called in the trade " holloware ") industry has been very largely replaced by the manufacture of similar articles in aluminium (see p. 431).

The trades of Birmingham are of such bewildering variety that it is impossible to give an adequate selection. So many of them, moreover, involve the use of other metals than iron and steel that the discussion may best be deferred.

(6) *The Smaller Midland Coalfields.*

(*a*) *North Staffordshire.*—Most of the iron smelted in this region is sent away, either as pig-iron or as semi-finished steel, to other areas, notably South Lancashire. The small engineering industry is concerned chiefly with foundry products and with machinery for the local industries, *e.g.* reinforced-concrete engineering at Stafford and pottery tools and machinery in the Five Towns.

(*b*) *Warwickshire and Leicestershire.*—This group, like Derby and Nottinghamshire, has a number of miscellaneous iron and steel industries. Stoves and grates are again prominent, as at Warwick and Leamington. Coventry has a vast trade in castings, forgings, and tools for its great motor, cycle, and aeroplane industries. Leicester makes, amongst other things, heating and ventilating plant, machinery for its own hosiery and boot and shoe trades, and stone-crushing apparatus (possibly a result of the proximity of the Charnwood quarries); and Rugby, as mentioned above, is one of the chief British centres for the manufacture of all kinds of electrical apparatus and machinery.

(7) *South-eastern Great Britain.*—The scattered engineering industries of the region lying south-east of a line from the Humber to the Bristol Channel owe their origin in many cases to the agricultural implement manufacture which arose at certain nodal points in this, the essentially arable part of Britain.[1] In other cases the industries have developed largely because (i) good railway facilities permitted easy access to sources of raw material; (ii) the local population provided at one and the same time a ready market for the articles produced and a source of labour supply. Of the towns where agricultural machinery formed the basis of the engineering industry, the most important are Lincoln, Gainsborough, Grantham, Thetford, Leiston, Ipswich, Colchester, and Rochester. In most cases the outlook has broadened, however, and other types of machinery are now more important than ploughs and reapers. Lincoln, for example, is probably the world's chief centre for the manufacture of excavating machinery: Ruston-Bucyrus steam

[1] This industry began, no doubt, by the keener farmers inventing their own mechanical devices, and became commercialised by the setting up of workshops in the market towns where the farmers congregated. Cf. *Victoria County History*, Lincolnshire, Vol. II, pp. 394–396.

shovels are used the world over. In addition, every type of road locomotive (steam rollers, traction engines, etc.) is made, together with a variety of agricultural machines and boilers and engine parts. Gainsborough makes dredges; Ipswich makes cranes, railway material, and electric road vehicles; Colchester deals in boilers and gas engines; Grantham has a large output of petrol-driven farm machinery and road rollers of all kinds.

Of the second class of towns the locomotive-building centres have already been alluded to. A few others may be cited as examples, but it must be remembered that, as pointed out previously, almost every town has an engineering works of some kind. Northampton makes stoves and grates and boot-making machinery; Bedford such things as pumps, oil engines, and electrical gear; Luton makes motor cars and refrigerating plant; Guildford specialises in mowing machinery; Yeovil makes oil engines; and Oxford has already been mentioned in connection with the motor-car industry.

Despite the absence of coalfields, this south-eastern region, taken as a whole, is the greatest engineering province of all. True, it is unlike the other regions in being far more widespread and in containing far more numerous and scattered individual centres, but within it the great city of London, as the table on p. 410 shows, is the second largest employer of engineering labour in the country. The multifarious engineering trades of London are referred to elsewhere (pp. 438, 606–8), but we might note here the importance of the electrical and motor trades and of the miscellaneous group. To provide raw material for some of these industries London has no less than 568 foundries (269 iron and 299 non-ferrous), ten per cent. of all those in the country.

Finally, attention may be called to South Wales. In this area neither shipbuilding nor any great engineering industry has developed [1] despite the early importance of the iron industry. The reason is to be found (*a*) in the location of the early smelting works in narrow valleys miles from the coast, and (*b*) in the great development of the tin-plate industry (*vide supra*) which absorbs most of the steel output. Only the manufacture of rails and sections, an industry lying on the border line between the *production* of iron and steel and engineering proper, is of any importance. This absence of any great manufacturing industry has been largely responsible for the disastrous unemployment in eastern South Wales, which has resulted from the decline of the inland centres and the working out of the best coals in that same north-eastern region.[2]

[1] Newport was quite an important shipbuilding centre in the days of wooden ships, but the industry declined when iron came into favour.
[2] See *Industrial Survey of South Wales*, Chapter III.

EMPLOYMENT IN ENGINEERING INDUSTRIES, 1931
(In Thousands)

Area	General Engineering	Shipbuilding, Marine Eng.	Electrical Eng.	Vehicles	Cutlery, Tools	Other metal industries[7]	Total
Scotland	42	33	7	22	1	23	128
North-East [1] . .	20	28	7	5	—	5	65
Lancs. & Cheshire .	85	21	47	32	1	31	217
W. Riding . . .	43	1	8	16	22	21	111
W. Midlands [2] . .	47	1	44	114	12	117	335
E. Midlands [3] . .	30	—	8	19	1	8	66
S. Wales [4] . . .	4	3	2	4	—	4	17
South-East [5]. . .	106	42 [6]	109	107	4	65	433
(*Greater London*) .	*73*	*7*	*86*	*57*	*3*	*54*	*280*
Total persons employed . . .	423	151	242 [8]	348	43	276	1,483
Unemployed. . .	101	128	35	62	10	57	393
Total, 1921 . . .	623	410	175	375	56	270	1,910

Notes : [1] Northumberland, Durham. [2] Gloucs., Hereford, Salop, Staffs., Warwick, Worcs. [3] Derby, Leics., Northants., Notts. [4] Brecknock, Carmarthen, Glamorgan, Monmouth. [5] Beds., Berks., Bucks., Essex, Hants, Herts., Kent, London, Middlesex, Oxford, Surrey, Sussex. [6] Naval dockyards account for 23,000 of these, and most of the remainder are engaged in ship-repairing in the ports of London and Southampton (cf. Fig. 199). [7] There is a very slight overlap with non-ferrous industries here, as some small brass-using trades are included. [8] The great increase over 1921 is undoubtedly largely the result of the growth of wireless and of the great housing boom.

TOTAL EXPORTS OF MACHINERY

Year	Tons	Value (£1,000)
1913	746,265	37,013
Average 1921–25	463,913	52,899
1926	474,707	45,526
1927	512,156	49,921
1928	565,960	53,721
1929	562,263	54,350
1930	481,886	46,974
1931	329,264	33,012
1932	301,178	29,590
1933	276,312	27,143
1934	335,030	32,806
1935	380,192	38,484

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CHAPTER XIX

THE NON-FERROUS METAL INDUSTRIES[1]

Introductory

THE term non-ferrous applies to all metals other than iron. Of a somewhat lengthy list, however, we are only concerned with a few which are in everyday use for domestic and industrial purposes. These fall roughly into three groups :—

(1) Some of the *baser metals*, such as tin, lead, copper, and zinc, have from very early times been wrought extensively in various parts of Britain, and the home-produced ores, though now almost negligible and supplemented by imports of ores, concentrates, and metal, have given rise to smelting and manufacturing industries of major importance.

(2) Others of the *baser metals*, such as nickel, chromium and aluminium, have found an increasing number of industrial uses during the present century. They are mostly imported.

(3) Ores of the *precious metals*, gold and silver, have never been worked in any great quantity in Britain,[2] but the demand of a highly civilised and, on the whole, wealthy community for jewellery, plate, and ornaments is responsible for the existence of a large industry concerned with the refining and fabrication of the imported metals.

Like all other mining activities, the winning of non-ferrous ores is a " robber " industry, that is to say, once the ore has been removed from the earth there is no means of inducing the growth of a further supply, and the only available course is to close and abandon the mine. Although this is true of all mining, however, —and we have already seen in Chapter XVII the examples of the coal and claybands of the Black Country and of the Cleveland ironstone—it is especially evident in the case of the non-ferrous ores. Coal, like most of the British iron ores, occurs in fairly thick seams, interbedded with unproductive measures ; and the investigation of the underground extension and probable reserves is a matter of comparative simplicity. The characteristic mode of occurrence

[1] By S. H. Beaver.

[2] Considerable quantities of silver have from time to time, in the past, been obtained from argentiferous ores of lead, in the Mendips, Derbyshire, and elsewhere. See also pp. 322, 414.

of the non-ferrous ores, on the other hand, is in the form of veins, often more or less vertically disposed, and irregular masses, the outcrop of which gives little or no indication of the amount of ore existing underground. Consequently, an ore which may on the surface appear extremely valuable may quickly peter out or alter its character when traced downwards and become almost worthless, whilst untold wealth may exist beneath poor surface indications. The working of non-ferrous ores is thus a much more speculative and ephemeral business than coal or ironstone mining, and is subject to more violent fluctuations of output and profits. It is an occupation, moreover, subject to a greater extent than these industries, to what economists call the " law of diminishing returns "—the more ore is removed from the mine, the more difficult and costly is it to obtain a further supply, for the mine must go deeper, more water must be pumped out, and there will be greater expense for ventilation and haulage. The conditions under which veins and masses or ore may occur are many and varied, so that no two mines, generally speaking, will have identical production costs. It follows then that some concerns in a mining area may be making large profits whilst others are, at least temporarily, running at a loss. The discovery of a new vein, or the opening up of a new ore-field, may quickly stifle, owing to the disparity in working expenses, an old area which may once have been of major importance. Thus the working of a non-ferrous mining field is not controlled solely by the local geological and geographical conditions. Much metal wealth, especially of tin and lead, still remains locked up in British rocks, but the once important veins of Cornwall, Derbyshire, and elsewhere cannot under present economic conditions hope to compete with the large-scale output from much richer areas abroad; the result being that the mining of non-ferrous ores in Britain is now virtually an extinct industry,[1] and the manufactures to which the home deposits originally gave rise must now be carried on almost entirely with imported foreign ores, concentrates, or crude metal.

There are many areas of the country where non-ferrous ores have been worked, and many thousands of extinct mines (some 4,000 disused lead mines in Derbyshire alone). But the life of a metalliferous mine is generally, with some very notable exceptions, comparatively short. Hunt calculated [2] for a 30-year period in the second half of the last century that of 220 Cornish mines only 35 had a life of over 20 years, whilst no less than 114 were productive for less than five years. As every mine must have a dump heap of

[1] In 1938, according to the List of Mines, some 3,000 men were employed in the mining of non-ferrous ores: lead (with zinc) gave employment to about 2,100, and tin (with arsenic and tungsten) to nearly 900. Of the 40 mines recorded as active, however, only 6 employed more than 100 men; the largest lead mines were Millclose (Matlock), Halkyn (Flintshire), Greenside (Lake Dist.); the chief tin mines were South Crofty (Pool), Geevor (Pendeen), and East Pool (Carn Brea).

[2] Quoted in *Mem. Geol. Surv., Min. Res.*, Vol. XXVII.

the useless rock dug out during the mining operations, and an erection of some kind at the head of the shaft, it is obvious that the effect on the landscape of those areas which have been thoroughly worked in the past must be considerable; and many a Cornish and Welsh panorama is marred by the ugly excrescences which betoken an activity which is, alas, rapidly fading into insignificance.

The industries based upon the non-ferrous metals and their extraction fall naturally into two distinct divisions: (*a*) the smelting and refining of the ores, and (*b*) the working up of the metal into manufactured articles. The geographic and economic influences bearing upon the location of the two branches are rather different. In the case of the smelting it must be borne in mind that most non-ferrous ores are very much poorer in their metallic content than ores of iron. A percentage as low as five per cent. may prove profitable if the ore is in sufficient quantity and easily accessible. The ore from the world-famous Anglesey mines, once the most productive in the world, only averaged four per cent. of metallic copper. It is thus not an economic proposition to smelt the ores far from their place of origin, unless cheap water transport be available, or unless the ore can be conveniently concentrated so that its metallic content is increased, say, to over 50 per cent. With inland ores smelting will most probably take place at the mines; should the ore lie near the coast it may be exported raw or in concentrated form to ports more favourably situated with regard to coal. The Derbyshire lead was always smelted on the spot; the Cornish copper ores were sent across the Bristol Channel to the ports of south-west Wales.

The location of the manufacturing industries is dependent upon at least three factors, the existence of a supply of raw material in the form of refined metal, a suitable labour supply, and the presence of a market for the finished goods. Should the market be a scattered one, it can scarcely be expected to influence the siting of the works, for one locality would be as good as another. Under these circumstances the factories may be set up, either in the vicinity of the smelting and refining plants, or distributed in a haphazard fashion over the country. If, on the other hand, the market is localised in a particular region or regions, the tendency will be for the manufacture to take place as near as possible to those areas. A second consideration concerns the wastage of the raw materials during the process of manufacture. If there is little or no waste the amount of material to be transported is much the same whether the raw materials or the finished goods are sent, and so it matters little where the industry is located on a line drawn from the source of the raw materials to the market. If, however, there is a great wastage of material the market will exert much less attractive power, and the manufacture will tend to be located near the source of supply of the raw material.

With these general principles in mind, we may proceed to examine in some detail the past and present distribution of the non-ferrous metal industries in Britain, paying special attention to the changes in location which have occurred, and to the geographical influences (in this case mainly a combination of geological and economic factors) which have been foremost in producing them.

THE DEVELOPMENT OF THE NON-FERROUS METAL INDUSTRIES

From the earliest times to the reign of Elizabeth [1]

The early history of the working of non-ferrous metals, like that of iron, is lost in obscurity. It is probable, however, that the western end of the Cornish peninsula, with its indented rocky coast, and the adjacent Scilly Isles were the Cassiterides to which the Phœnicians came from at least the fifth century B.C. to trade in tin with the natives.[2] By the time of the Roman occupation there is abundant evidence, both literary and *in situ*, of the great use which the Romans (with the help doubtless of their slaves) made of Britain's metal wealth. The historian, Diodorus Siculus, writing of the Cornish tin trade just after Cæsar's time, records the collection of the smelted tin on Ictis Isle (probably St. Michael's Mount) and its purchase by the merchants for shipment to the coast of Gaul and thence to Marseilles and the Mediterranean, and a block of tin such as he describes has actually been dredged up from Falmouth harbour. But it was lead that the Romans chiefly prized, and the results of their mining and smelting operations are to be found in such widely scattered localities as the Mendips, Derbyshire, Flintshire, western Shropshire, Alston Moor, and Leadhills. A very fair technique had been attained, for numerous pigs of lead have been unearthed bearing the inscription " ex arg " (*ex argento*, freed from silver), and Pliny refers to the large supplies of lead pipes and sheeting which Britain produced. In addition, the Romans are known to have worked the copper ores of Anglesey and Shropshire, whilst it is not improbable that they obtained a certain amount of gold from mines in North Wales and Carmarthenshire.

All these early efforts were either stream-works or else mere

[1] Much valuable literature on this subject will be found summarised in the *Victoria County Histories* (Vol. II in each case) of Cumberland, Derbyshire, Durham, Somerset, and Yorkshire.

[2] Cassiterides, from Greek *cassiteros*=tin. See W. C. Borlase, *A Historical Sketch of the Tin Trade in Cornwall*, 1874. Herodotus (fifth century B.C.) and Strabo (first century B.C.) each refer to the Cassiterides and their tin, and Polybius (second century B.C.) and Diodorus Siculus (first century A.D.) both mention tin in Cornwall, but no definite pronouncement seems to be made identifying the one with the other. A Phœnician bronze ornament has been found at St. Just.

surface scratchings. The natural environment in which the ores occurred was particularly favourable to their discovery and utilisation. The veins were to be found in upland areas formed by palæozoic rocks, and the thin soils and scanty vegetation of much of these districts permitted the surface exposure of the minerals; the heavy rainfall of most of the upland regions entailed a great deal of erosion by rushing torrents which would further expose and erode the veins and would sort and re-deposit the ore in their beds; whilst the peat cover of much of the moorland and the forests of the slopes would provide ample fuel for smelting purposes. The Cornish tin ore was probably all obtained from detrital deposits in which, owing to its high specific gravity (6·8), it accumulated whenever the velocity of the streams was insufficient to carry it further; and the ores of the other regions were obtained either from streams or by shallow diggings at the outcrop of the veins.

There are few records of mining or smelting during the Saxon period, and the only noteworthy reference in the Domesday Survey concerns lead mines at Wirksworth and other places in Derbyshire.[1] The first documentary evidence begins in the twelfth century, and the long series of Pipe Rolls contain frequent references to the mining industry, in which tin and lead are the chief items.

Tin.[2]—In the twelfth and thirteenth centuries, the Cornish tin trade was mostly in the hands of Jews who may or may not have been the descendants of Phœnicians who settled in the country. Even to this day certain ruined smelting hearths and slag dumps are known as "Jews-houses." The banishment of all Jews from England in 1290 left Cornwall without its merchant smelters, but a revival of industry took place in the early fourteenth century with the passing of the first Stannary Laws (Latin *stannum* = tin). So great a part did tin mining and tin smelting play in the lives of the people of Devon and Cornwall that from this time onwards for over four centuries the "Stannaries" had their own Parliaments,[3] and a series of laws governing the mining, coinage, and disposal of tin. "Coinage" was the marking of the tin bars for taxation purposes. It took place generally once a year at certain "coinage towns," whither the bars were brought from the neighbouring smelting houses. In Cornwall, Lostwithiel, Liskeard, Bodmin, Truro, and Helston were appointed as coinage towns, and in Devon, Tavistock, Ashburton, Plympton, and Chagford. The chief uses of tin were for the manufacture of pewter, as an alloy in bell-founding

[1] It is difficult to believe that tin-mining had died out—but possibly, being considered as royal property, the mines were not recorded in a survey, the main purpose of which was the ascertainment of the value of estates for taxation purposes. (G. R. Lewis, *The Stannaries*, p. 34.)

[2] G. R. Lewis, *op. cit.*, Chapter II.

[3] The parliament of the Devon "stannary" met on Crockerntor and later at Tavistock; that of Cornwall met at Lostwithiel and afterwards at Truro.

and as a soldering material. The pewter trade assumed large proportions in the fifteenth and sixteenth centuries, and a considerable export took place, largely controlled by Venetian merchants.

Lead.[1]—The twelfth and thirteenth centuries saw great activity all over the country in the erection of great buildings—especially churches and monasteries—and as a result the demand for lead for roofing and drainage purposes was greatly stimulated. Derbyshire was the chief centre, but the Pennine region of Durham and the Mendip Hills also had many mines and smelting hearths. Smelting of the galena was performed in "boles" (simple hearths surrounded by a few bricks) using brushwood as a fuel. These boles were nearly always placed on the brow of a west-facing hill, in order to catch the breeze. Many such ancient furnace sites are known in Derbyshire and Durham, and the name "Bole Hill" is of frequent occurrence in the former county. The fourteenth century probably witnessed the introduction of charcoal as a fuel, and also the development of water-wheels for working bellows which could create the necessary blast—with a consequent descent of the smelting industry into the valleys. At this time lead ranked with wool and leather as one of the chief exports of Britain.

From the Reign of Elizabeth to the Present Day

The history of the non-ferrous metal industries from about 1550 to the present day may be briefly summed up as follows. A great fillip was given to mining and smelting in the Elizabethan period by the introduction of workmen from the Continent who could and did teach the English how best to search for and make use of the metal wealth which the country possessed. The small existing industries were considerably expanded, and a number of new manufactures, such as those dealing with copper and brass, came into being. After a period of comparative quiescence during the troublous times of the middle seventeenth century, a great revival took place. The end of that century and the beginning of the next marked the foundation, in various parts of the country, of many branches of the industry which have survived, though perhaps in a modified form, until the present day. The increasing uses to which the metals were being adapted, together with the new lease of life given to the mining industry by the installation of the steam engine as a means of pumping out water from the ever-deepening mines, brought about a continued expansion of the industry during the eighteenth century. Stimulated by the development of manufacturing which accompanied the Industrial Revolution, and by the increasing employment of non-ferrous metals as well as iron in the fabrication of machinery, the output of British mines reached a maximum during

[1] See especially *Victoria County History*, Derbyshire, II, 323–349; also J. W. Gough, *The Mines of Mendip*. Oxford. 1930.

the period 1840–1880. About the same time, too, foreign ores, especially of tin and copper, began to be imported, and the smelting trade, notably in the Swansea area, enjoyed a period of great activity. Gradually, however, it became increasingly uneconomic to transport bulky ores for thousands of miles from overseas, and as this trend has coincided with the decline, almost to nothing, of the home ore production, smelting has almost died out, and the structure of the non-ferrous metal industry has been radically changed. Most branches of the industry are carrying on as a result of momentum acquired during the period of prosperity, and are now based upon imported semi-finished material in the shape of ingots and bars of refined or partly-refined metal.

A more detailed examination of the development and distribution changes during this period will help to explain how the British non-ferrous metal industry and its dependants have been built up, and the part which they play in the economic organisation of the country at the present time.

In the middle of the sixteenth century, although tin and lead were still being worked, England lagged a good deal behind the Continent in industrial development, and early in the reign of Elizabeth it began to be realised that in order to improve conditions at home, to increase foreign trade, and to maintain the defences, metal industries were very necessary, especially those dealing with copper and brass, since those substances were used for the production of ordnance as well as for domestic utensils.[1] Accordingly, invitations were extended to certain German metal workers to take up their abode in this country and pursue their trade with British ores. In 1564 a small group of skilled men from Augsberg, led by one Daniel Höchstetter, landed in England, and in the following year, after rich copper deposits had been located at Keswick, several hundred workmen from the Tyrol were "imported" and smelting works were set up. Many groups of German miners and metal workers subsequently came to Britain and settled in the mining districts, notably in Cornwall, the Mendips, and in Northumberland, or started new metal industries in various parts of the country.[2] Two companies were subsequently formed and granted charters, one the "Mines Royal Society," whose privilege it was to work for precious metals and copper in certain areas, and the other the "Society of the Mineral and Battery Works," who were authorised to get calamine (zinc ore), and to make brass and battery goods (*i.e.* articles, such as pans and kettles, made from copper or brass beaten into thin sheets). In 1583 copper ore began to be worked in western

[1] See on this subject H. Hamilton, *The English Brass and Copper Industries to 1800.*

[2] Many of the early metal-working establishments owe their foundation, not to any geographical advantages possessed by the site, but to the settling of a group of foreign artisans.

Cornwall, and as there was no fuel there available, a smelting house was set up at Neath, in South Wales, to deal with the ore. A little later copper ore was discovered at Ecton Hill, Staffordshire, and Alderley Edge, Cheshire, and smelting works were set up in the vicinity. The chief essentials of the smelting industry were ore supplies and the availability of fuel. At Keswick peat was used; at Neath charcoal and coal. The brass industry, on the other hand, needed calamine and copper as its raw materials, and power for the hammers, and was best placed near to a market. The first brass works were at Tintern (using the calamine lately discovered in the Mendips, together with fuel from the Forest of Dean), at Nottingham (using Derbyshire calamine and Staffordshire copper), and on small streams near London (at Isleworth and Rotherhithe). One of the principal uses of brass, apart from "battery goods," was for wire and pin-making—the chief activity of the Mineral and Battery Society was the production of iron and brass wire for wool-cards.

The political instability of the Civil War and Protectorate period, and the monopolistic control exercised by the two companies mentioned, were unfavourable to great progress;[1] but with the removal of the monopolies in 1689, the way was opened for a considerable expansion in the copper and brass trades, and the improvements in mining and smelting technique which naturally followed, further increased the possibilities of development. During the eighteenth century several areas participated in the general growth of the non-ferrous metal industries. Around Swansea and Neath, the chief activity was smelting, using copper ores imported by sea from Cornwall and Ireland (Co. Wicklow), and silver-lead ore from Cardiganshire. Swansea was at this time the chief port in South Wales—and the nearest to Cornwall—and as it possessed a navigable river, easy access to coal supplies and a large area of flat and otherwise useless land behind it, it offered a very favourable site for the growth of the copper trade. All these advantages were largely shared by Neath. In the Bristol district the ease of the import of Cornish copper ore,[2] the proximity of the Mendip calamine deposits, and the water power provided by the Avon and its tributaries, resulted in both smelting and brass manufacturing. The third region comprises north Staffordshire, north-east Cheshire, and south Lancashire. Here the initial impetus was given by the local copper ores and the calamine of Derbyshire, and the ease of import of copper ore from Ireland. Quite early in the eighteenth century, smelting works were established at Warrington,[3] and copper and brass

[1] In 1670 and again later the copper required for a new coinage had to be imported from Sweden.

[2] In 1720 no less than forty ships were constantly employed to carry Cornish ore to Bristol and Swansea.

[3] Warrington at that time had just, by the dredging of the Mersey, been made available as a tidal port.

battery and wire works in the Cheadle district, where water power from the River Churnet was utilised. The greatest development here, however, came after the discovery, in 1768, of a whole hill of copper ore in the island of Anglesey.[1] Although some smelting was done at Amlwch, near the mines, much of the ore was exported; St. Helens and Liverpool developed smelting works, and the Macclesfield area took up the brass industry. Considerable quantities of Anglesey ore were also exported to Swansea, where many new works were established. Smelting was tried in Cornwall on several occasions, but none of the attempts really succeeded, principally because of the coal difficulty, but also because the greater part of the British copper-smelting industry was under the control of large combines which could effectively crush any competition from less well organised competitors.[2]

The chief outlets for the copper and brass made were the East India Company, which largely controlled the export trade, and the metal trades of Birmingham.[3] These deserve further comment. In the sixteenth century Birmingham was already a centre of the finished iron industry (*vide supra*, page 361). When brass manufacture first began to develop, early in the seventeenth century, Birmingham was thus a natural home for it; brass is more easy to fabricate than iron, and the skill of the ironworkers could be readily adapted to the use of the new metal. The influx of Dissenters—people of strong character and willing workers—into the free (*i.e.* non-corporate) town of Birmingham, undoubtedly gave that town a great advantage from the point of view of labour supply during the last quarter of the century; and the age of luxury heralded by the restoration of Charles II. called for large supplies of ornamental metal articles. Bad road transport and the lack of navigable rivers made Birmingham specialise in small and valuable goods, whilst the heavy iron trades were driven westwards in search of coal and water power. The development of the smelting and brass-making industries at Bristol and Cheadle, together with the expansion of the export trade to Africa and the Indies, gave Birmingham an impetus in the manufacture of metal wares that has sufficed to maintain its supremacy in the trades, even to the present time; and the desire to break the power of the combines (*vide supra*) led to the setting up of brass manufacturing (as opposed to the fabrication of brass articles) towards the end of the eighteenth century. Besides Birmingham, Wolverhampton and Walsall also began to develop brass and copper industries; in Wolverhampton the industry grew up primarily as an associate of the lock trade; in Walsall of the saddlery and harness trades.

[1] The Parys mine quickly became the largest in Europe, and at the end of the century was yielding about 3,000 tons of metallic copper annually.

[2] Hamilton, *op. cit.*, Chapter VI.

[3] Hamilton, *op. cit.*, Chapter V.

The eighteenth century witnessed the lead industry at the height of its prosperity. Lead had not been affected to such an extent as the copper and brass trades by the disturbing effects of control by large companies, export and import restrictions, and fashion changes, but, favoured by a flourishing export trade, had undergone a steady development. In Derbyshire the lead miners, most of whom were individualists working for their own ends, and selling the ore from their own small digging or mine to merchant smelters, were governed by laws even more numerous and complicated than the Stannary Laws of Devon and Cornwall; and as most of the mines were small and the laws permitted anyone to dig for lead anywhere, and to remove timber for propping and smelting, the effect on the landscape of the lead-mining area lying between Wirksworth and the Peak Forest has been considerable. Other lead-mining and smelting regions at this time were Flintshire, the Leadhills region, the Mendips (though the lead here began to be subordinate to zinc—*vide infra*), and the Pennines of north Yorkshire and western Durham.[1] Lead was used for sheeting, pipes, and bullets.

The tin-mining industry of Cornwall was given a considerable impetus after about 1730 by the growth of the tin-plate trade in South Wales (cf. Chapter XVIII). Despite the commencement of the import of tin ore from the East Indian island of Banka in 1760, this trade, combined with the export market provided by the East India Company, sufficed to maintain the Cornish mines in a state of comparative prosperity. A considerable amount of tin-smelting was performed in Cornwall—probably owing to the very early start which the industry had, using peat and charcoal as fuel, and to the fact that unlike the copper trades, tin mining was confined to the one area, and so not subject to competition from better situated producers.

The need of the brass industry for calamine has already been mentioned. In the early days of brass manufacture prepared calamine was used to mix with copper. About the middle of the eighteenth century, however, methods of extracting metallic zinc, or spelter, from both calamine ($ZnCO_3$) and blende (ZnS) were discovered, and later spelter was used in brass making. The first zinc-smelting works was set up at Bristol in 1743, and thereafter the mining of zinc ores became of still greater importance in the Mendips, where nearly 100 mines were in existence at the end of the eighteenth century.

The outstanding technical developments which influenced metal production in the nineteenth century were concerned with (*a*) more efficient mining methods—*i.e.* better drainage and ventilation; (*b*) better treatment (washing and crushing) of the ore, so as to get the utmost possible metal out of it; both of these were greatly assisted by the employment of the steam engine; (*c*) improved

[1] A. E. Smailes: "The Lead Dales of the Northern Pennines." *Geography*, XXI. 1936. 120–129.

methods of smelting—the introduction of cupolas and reverberatory furnaces using coal or coke as a fuel; (*d*) the introduction of rolling as opposed to battery in the production of sheet metal. The development of coke smelting and the use of steam power did not, however, as with the iron industry, tend to concentrate the non-ferrous metal industry on the coalfields; for the lean ores were not found in the Coal Measures, and the smelting industry was located either on the ore-fields, as in the case of Derbyshire lead and Cornish tin, or near the coast, where either home or foreign ores could be easily imported, as in the Swansea and Bristol areas and in South Lancashire.

The progress of the non-ferrous-metal industries during the nineteenth and early twentieth centuries can be best treated under

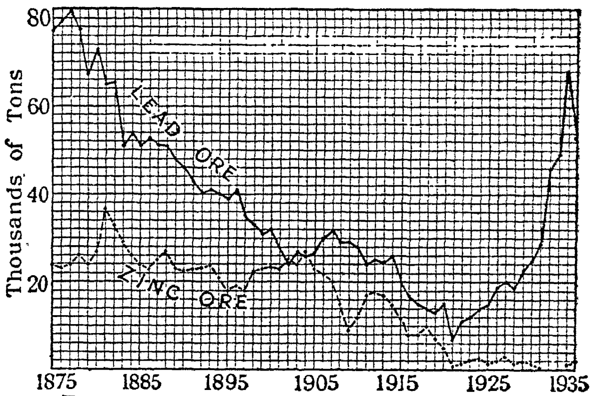

FIG. 204.—Lead- and zinc-ore production in Britain.

Lead: 1936, 39; 1937, 33; 1938, 38 (Th. tons). *Zinc:* 1936, 8; 1937, 13; 1938, 19 (Th. tons).

three headings: (1) Ore mining; (2) Ore import and smelting; (3) Manufacturing trades.

(1) *Mining.*—Taken as a whole, production of non-ferrous ores reached its maximum during the middle period of last century, though different ores and different regions reached their climax at varying dates. In the early years of the century, Cornwall and Devon were producing about half of the world's copper ore, but although the actual amount increased until about 1860, the tremendous outputs of Chile and the United States soon dwarfed this into insignificance. The Anglesey ores were gradually worked out, and although between 1850 and 1870, North Wales and the Lake District were fairly productive, a rapid decline quickly set in. In lead mining, the peak period was 1850–1870 when the average output was over 90,000 tons of ore annually. Derbyshire no longer dominated the industry, the northern Pennines and North Wales producing large quantities. The Cornish tin mines continued to increase their productivity, reaching a maximum between 1870 and

1890, subsequently declining. Zinc mining attained its greatest output in 1881 and declined gradually.

The general rapid decline of ore production in the last quarter of the century may be ascribed to several causes. Mining conditions were becoming more and more unfavourable, and the best ores were worked out; prices during the great depression of the 'seventies dropped to ruinously low levels, rendering the working of many mines quite unremunerative;[1] the rapid growth of steam shipping, and the development of large bodies of ore in foreign countries, made for easy import of ores and concentrates—copper from Chile and the United States, lead from Spain (where it was a by-product of the silver mines), tin from Australia and Malaya.

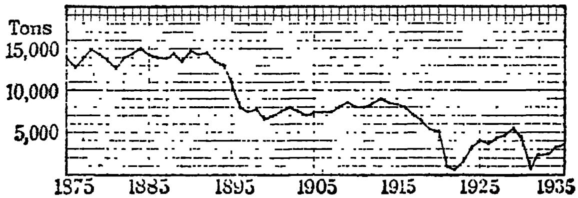

FIG. 205.—Tin-ore production in Britain.
1936, 3,558 tons; 1937, 3,367; 1938, 3,172.

(2) *Smelting.*—The nineteenth-century smelting industry affords some excellent examples of the results of changing geographical values. The rise of Swansea has already been mentioned. The expansion of the Cornish output of copper ore continued to stimulate the erection of new works on the River Tawe; four (also one at Llanelly) were actually built during the first decade of the century. After about 1830, foreign ores from Cuba and Chile began to supplement the Cornish supplies, and the growth of smelting at Swansea was, as it were, cumulative: the very existence of a number of smelting works, and of a labour supply skilled in metal working was sufficient to attract any new enterprises to the vicinity, and Swansea assumed the position of the world's chief copper-smelting centre.[2] In the 'sixties, when the trade was at its greatest, Swansea boasted eight copper-smelting establishments out of a total of sixteen in South Wales, and twenty-four in the whole country. The effect of this vast industry upon the landscape has been disastrous. The sulphurous fumes belched forth from hundreds of chimneys during the roasting and smelting operations destroyed the vegetation for miles around, especially on the east side of the Tawe (due to the prevailing westerly winds) and the enormous slag dumps, together

[1] It should be remembered also that unless pumping is carried on a disused mine quickly gets flooded and the outlay involved in putting it again into working order is usually prohibitive.

[2] See Rider and Trueman, *South Wales*, Chapter VIII; also for greater detail, G. Grant-Francis, *History of Copper Smelting in the Swansea District*, and D. T. Williams, *Economic Development of Swansea*.

with numerous ruined factories, combine to make the entry by rail into Swansea a most depressing journey. The increase of ore-field smelting, however, reduced the industry at Swansea to a state when economic competition with Chile, the United States, and Australia was no longer possible and, as a result, from the late 'eighties onwards copper smelting declined until it no longer exists. Instead, smelted copper ("matte" or "regulus") is imported and refined. The other smelting activities of Swansea (lead and zinc) were formerly of much less importance, but strangely enough they have survived the copper smelting (*vide infra*).

FIG. 206.—Copper-smelting works in 1861.

The only other copper-smelting centre of importance in the nineteenth century (apart from the declining ore-field smelters at Amlwch and Cheadle) was St. Helens, with the origin of which we have already dealt (Fig. 206).

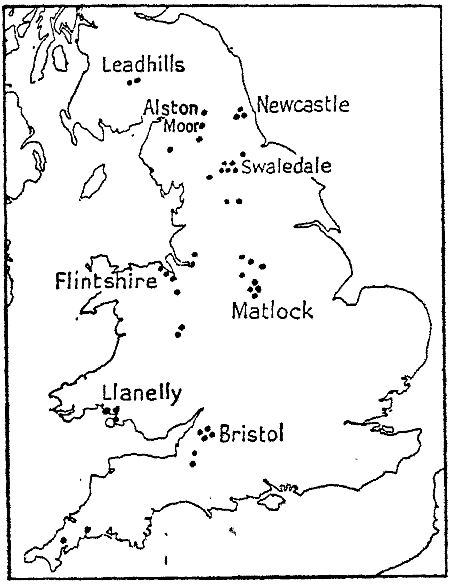

FIG. 207.—Lead-smelting works in 1870.

The smelting of lead was much more widely distributed, owing chiefly to the fact that rich ores were abundant in many parts of the country, but also to the ease of smelting and the absence of destructive fumes (Fig. 207). In Derbyshire (centring upon Matlock), in Cornwall, Flintshire, Shropshire, the north Pennines, the Mendips, and at Leadhills, the smelting works were located in close proximity to the larger mines. Bristol, also an important centre for other non-ferrous metals, used ore from the Mendips or imported from North Wales. A few works in the Llanelly

region used north Welsh ore, and Newcastle-on-Tyne smelted ores from Alston Moor, or imported by sea. The rapid decline of mining, however, has considerably reduced the number of works in operation ; only the Derbyshire and Flintshire ore-fields remain in the smelting trade, and the greater part of the British lead production is now derived from imported pig-lead, which is refined principally at or near the chief seaports.

Although certain of the Cornish tin smelters for a time actually imported East Indian and Australian ore for smelting, the trade has suffered the same fate as the rest of the industry ; concentrates are now imported to be smelted at Liverpool or London, and refined tin bars are imported for the tin-plate trade.

(3) *Manufacturing.*—If, during the nineteenth century, Swansea merited the title of "metallurgical capital" of Britain (in non-ferrous metals only, of course), Birmingham to an even greater extent deserved to be regarded as the metropolis of those industries concerned with the working up of the non-ferrous metals into articles of commerce.[1] The momentum which that city had acquired in the brass and copper trades during the eighteenth century, was sufficient to attract any new developments, and so greatly did the market for copper and brass expand during the first half of the nineteenth century that by 1860 brass manufacture was the leading trade in Birmingham. The development of the steam-engine had added a vast new market for brass and copper tubes, steam cocks, pressure gauges, etc., and the invention of a method of making seamless tubes in 1838 gave a further impetus to this branch ; the introduction of yellow or Muntz's metal for ship-sheathing early in the century, and the demand for "naval brassfoundry" to which the expansion of shipping gave rise, created a new market ; and the increase in domestic and municipal sanitation generated a large demand for taps, water-cocks, etc., whilst gas lighting opened up a new market for pipes and fittings. In 1830, the crucible method of brass manufacture (using copper and spelter) began to replace the old cementation process, and this, like Bessemer's converter in the steel industry, meant a considerable expansion of output, and a reduction of operating costs. Birmingham was, moreover, particularly well situated with regard to the accessories of brass manufacture—fireclay crucibles were produced at Stourbridge, and the local Triassic deposits furnished excellent moulding or casting sand. It is little wonder, then, that the number of people employed in the brass industry in the city rose from 1,800 in 1831 to 8,100 in 1861.

It was natural, too, that a city devoted so largely to the working of the baser metals should turn its attention to silver, gold, and the jewellery trade. Birmingham began with silver, but early in the

[1] See G. C. Allen, *Industrial Development of Birmingham and the Black Country.*

nineteenth century gold was being worked as well, and the increasing demand for jewellery in the early years of Queen Victoria's reign, together with the expansion of the gold trade following the "rushes" in California and Australia in 1849–51, brought about a rapid growth, and by 1860 the jewellery trade was one of the four largest in Birmingham, employing about 7,000 people, mostly small craftsmen working in their own workshop-dwellings. The introduction of electro-plating about 1840 opened up a vast new market. The silver-plate trade introduced into Sheffield about 1740 had been shared by Birmingham, and the two cities both profited very largely by the great demand which was set up by the cheapening of plated articles without any loss of utility and attractiveness.

To an even greater extent than the brass and copper industries the jewellery trade depended on foreign raw materials. As a consequence, when competition from better situated continental and American producers became keen, concentration upon high-class goods became a feature of the trade.

Both the brass and the jewellery trades survived in Birmingham and even expanded considerably, whilst the iron industry was rapidly declining. The cheapening of copper by reason of the huge foreign supplies available, and the vast increase in the use of steam-driven machinery, together with the fact that Birmingham had always been dependent on distant sources of raw materials, and so did not suffer, as in its iron industry, from the disadvantage of failing local supplies, combined to maintain and increase the prosperity of the brass trade. The jewellery industry, augmented by the introduction of jewel-cutting and by the continual increase of electro-plating, flourished likewise.

At the beginning of the present century we thus see the various branches of the non-ferrous metal industry very different in magnitude, and in relative importance, though not radically different in geographical distribution, compared with their condition in 1800. Smelting had declined almost to nothing; instead of ores, ingots of semi-refined or pure metal were being imported; and the manufacturing industry, helped by the creation of many new uses for the metals, had grown almost out of all recognition, especially in the Birmingham district.

Before dealing with the present condition of the industry, we must glance briefly at the sources of the raw materials; we can then study the distribution of the various branches of the industry and amplify the explanations hitherto given of the geographical factors involved.

OUTPUT OF NON-FERROUS METALLIFEROUS ORES (TONS)

Mineral	Chief localities	Average per cent. of metal in dressed ore	1913	Average 1921–25	Average 1926–30	1931	1932	1933	1934	1935	1936	1937	1938
Copper precipitate[1]	Cornwall Anglesey	63	163	149	123	109	90	64	22	77	138	79	70
Lead ore . . .	Derby Durham Cumberland Dumfries	80	24,282	12,048	21,583	29,502	40,633	49,056	68,122	52,859	39,093	33,411	38,134
Manganese ore .	Merioneth Carnarvon	30	5,393	1,214	624[2]	—	—	—	—	—	—	—	—
Tin ore . . .	Cornwall	60	8,355	2,195	4,566	919	2,025	2,337	3,224	3,535	3,558	3,367	3,172
Zinc ore . . .	Cumberland Derby Flint Dumfries	46	17,294	1,696	1,913	409	8	9	988	2,116	7,869	13,083	19,144[3]
No. of persons employed in all non-ferrous mining (including barytes) .	—	—	—	3,406	4,603	1,380	1,565	2,021	3,270	3,409	3,305	3,711	3,490

[1] Copper *ore*, 2,569 tons, 1913; practically none since 1920.
[2] 1926–8 only, none since 1928.
[3] Note this striking increase in zinc ore, which is almost all from the large lead mines named on p. 412*n*.

THE PRESENT CONDITION OF THE NON-FERROUS METAL INDUSTRIES

Home Supplies of Ore

Some details of the British metalliferous ores have already been given in Chapter XVI. It only remains for us to add the table on p. 426, showing the output of the post-War years compared with that of 1913.

Imports of Ores and Metals

It is obvious that the small quantities of metal to be obtained from the ores enumerated above could not form the basis of any large manufacturing industry. In order to maintain the vast industries which grew up during the nineteenth century, therefore, recourse must be had to the import of raw materials from abroad. The greater part of the raw material is in the form of crude metal (already smelted and perhaps refined) ; some ores and concentrates, however (notably zinc from Australia, and bauxite, the ore of aluminium, from France), are still imported by certain ports where the smelting industry, favoured by a coastal situation, is not entirely extinct (*e.g.* Swansea, Liverpool, Bristol).

NON-FERROUS METAL INDUSTRY : IMPORTS OF RAW MATERIAL, 1935

I. *Ores and Concentrates*

Material	Thousand tons	Chief countries of origin	Chief receiving ports [1]
Bauxite	194	France	Burntisland, Larne, Glasgow
Chromium ore	26	Greece, Southern Rhodesia	
Copper cement and matte [2]	31	Canada, Norway, Spain	Swansea, Port Talbot, Liverpool
Pyrites [3]	309	Spain	Liverpool [4]
Manganese ore [5]	228	India	Middlesbrough, Liverpool
Tin ore and concentrates	45	Bolivia, Nigeria, Chile	Liverpool
Tungsten ores	10	India, China	London
Zinc concentrates	152	Australia	Swansea, Bristol
Gold ore [6]	—	U.S.S.R., Canada, W. Africa, France	—
Silver ores [6]	—	Australia, Java, Canada, Peru	Liverpool, London

II. *Crude Metal*

Aluminium . . .	360	Canada, Switzerland, Norway	Liverpool, London
Antimony . . .	4	China	—
Copper	301	Chile, Canada, N. Rhodesia, U.S.A.	Liverpool, London, Manchester, Swansea
Lead	316[7]	Australia, India, Canada	London, Liverpool, Manchester, Newcastle
Tin	16	Dutch E. Indies, Br. Malaya	London
Zinc (Spelter) . .	148	Canada, Belgium, N. Rhodesia	London, Liverpool, Newcastle

[1] Where no port is given, no port imports in quantities sufficiently large to be recorded separately in Trade Statistics.

[2] Most of the matte reaching Swansea is copper-nickel matte from Canada used for the extraction of nickel.

[3] Pyrites includes both iron pyrites (FeS_2) and copper pyrites ($CuFeS_2$). Iron pyrites is imported for the sulphur and not for the iron. Copper pyrites probably represents about 250,000 tons out of the above total.

[4] Many ports receive iron pyrites since its chief use is in gas-works. Liverpool is the chief recipient of Spanish copper pyrites, used in the Lancashire chemical industry (cf. Chapter XXIII).

[5] Manganese ore is not imported for the production of metallic manganese, but is used in the steel industry; see Chapter XVII, p. 352. No further mention will be made of it in this chapter.

[6] Entered in the Trade Statistics by value only.

[7] Of this total 23,000 tons were re-exported.

CHIEF PORTS IMPORTING NON-FERROUS ORES, CONCENTRATES, AND CRUDE METAL, 1935 [1]

(Thousand Tons)

Port	Bauxite	Crude aluminium	Copper ore and matte	Copper bars	Pig-lead	Zinc ore	Crude zinc	Tin ores and conc.	Tin bars	Pyrites [2]	Total
Bristol	—	—	—	17	8	80	3	1	—	3	112
West Hartlepool . .	—	—	—	—	—	9	—	—	—	—	9
Liverpool	—	5	7	124	70	—	33	44	2	62	347
Manchester	—	—	—	34	32	—	6	—	—	37	109
London	—	15	—	81	160	—	64	—	13	32	385 [3]
Newcastle	—	—	—	1	23	—	20	—	—	3	47
Newport	—	—	—	—	—	—	1	—	—	4	5
Port Talbot . . .	—	—	3	3	—	—	—	—	—	—	6
Swansea	—	—	22	33	—	59	6	—	—	—	122 [4]
Burntisland . . .	108	—	—	—	—	—	—	—	—	—	108
Glasgow	—	—	—	1	9	—	8	—	—	42	70 [5]
Larne	39	—	—	—	—	—	—	—	—	—	39

[1] Excluding manganese ore; see note 5 to table above.

[2] See note 3 to table above.

[3] Includes small quantities of tungsten ore (8), nickel (3), and zinc sheets (9).

[4] Includes a small quantity of unwrought nickel.

[5] Includes 10,000 tons of chromium ore.

Besides continuing their smelting industry, though in a greatly reduced and modified form, these old coastal centres have also turned over to the working up of imported metal into sheets, bars, wire,

and tubes, and as a result they figure largely also in the second part of the table, p. 428. But the weight of a given quantity of crude metal will be very little reduced after manufacturing, and in consequence, unlike the ores, this raw material will stand the cost of transport to inland centres. Needing no special accommodation, it can be dealt with to a very large extent by the great ports, London, Liverpool, Manchester, in the course of their ordinary import trade. The large part which these ports play in the import of crude metal is, however, partly accounted for by the existence at all three of important refining and manufacturing industries; but London, especially, imports far greater quantities than its own works can consume, the surplus going to the Midlands or as far afield as South Wales (cf. Chapter XVIII, p. 379).

The Non-Ferrous Metal Industries considered separately

Aluminium.[1]—This, one of the most abundant metals in the earth's crust, has given rise to the youngest of the great non-ferrous metal industries. Its development dates really from about 1900, and the reason is to be found in the difficulty of reduction, and the comparative scarcity of readily usable ores. Although alumina is present in all clays, bauxite (a mixture of diaspore $Al_2O_3.H_2O$, and gibbsite $Al_2O_3.3H_2O$) (the name derived from Baux in southern France), is as yet the chief commercial source of the metal. The production of aluminium is effected in two stages: (1) by a complicated chemical process, nearly pure alumina is obtained from the bauxite; (2) the alumina is calcined and then reduced in an electric furnace employing a current of great intensity. It is the necessity for electric power on a large scale which has been the chief obstacle to the spread of aluminium manufacture, and which has caused the concentration of the industry mainly on hydro-electric power sites. In Britain, the production of the metal is divided into two quite distinct parts. The extraction of alumina from bauxite imported from France is effected at Burntisland; and a certain amount of Antrim bauxite (although much of this, having a high silica content, is used for the manufacture of alum and refractory bricks rather than for alumina) is treated at Larne. Between one-third and one-half of the alumina produced (the proportion is decreasing) is exported to Norway, where British companies have their own reduction plant. In Britain the reduction of the alumina is effected at hydro-electric power works which have been erected in the Scottish Highlands (at Fort William and Foyers (Inverness) and Kinlochleven (Argyll)) and in North Wales (at Dolgarrog). Although

[1] See W. G. Rumbold, *Bauxite and Aluminium* (Imperial Institute Monographs on Mineral Resources).

Burntisland and Larne are fairly conveniently situated with regard to bauxite [1] (import or local supply) and to the power stations, it is obvious that a great deal of transport is necessary before the metal aluminium is finally produced; and as the power stations are far removed from the great metal-working centres a further journey is necessary before the metal finally enters the market as a finished article. For this reason it is a great advantage that aluminium is a metal of extreme lightness (Sp. Gr. 2·7).

In thirty years many uses have been found for aluminium, based mainly upon its lightness combined with strength, malleability and ductility, and the ease with which it can be mixed with other metals. Unalloyed, it is used for electric cable wire (especially the bare overhead lines of the Grid), in motor-car and aircraft construction, and for hollow-ware (*i.e.* cooking utensils). Alloyed with copper, zinc, or with two or more other metals, for the purpose of combining lightness with tensile strength, it is used for pistons, cylinders, and other parts of aircraft and motor-car engines (as opposed to framework). The metallurgy of aluminium and its alloys is still in its infancy. The war gave a tremendous stimulus to the production of aluminium for aircraft, and the rapid post-1918 expansion of the motor industry has provided a new and more peaceful outlet. Aluminium is also employed in the manufacture of the explosive ammonal and the production of metallic paint. The aluminium-manufacturing industry may be divided into three parts: (1) Rolling and wire drawing are largely carried on in the metal-working district of south-west Lancashire (Warrington, Prescot, St. Helens, etc.); (2) The foundry industry is much more scattered, but its correlation with the motor-car industry is most marked; the most important centres being Coventry, Birmingham (and various Black Country towns), Manchester and Luton (cf. Chapter XVIII, p. 401). It was natural, considering the importance of the Birmingham-Smethwick-West Bromwich area in the brass and iron-foundry trades, that the first establishment for making aluminium castings should have been set up at Smethwick in 1900. The growth of the industry

PRODUCTION OF ALUMINA AND ALUMINIUM

(Thousand Tons)

	1928	1929	1930	1931
Alumina	33	35	38	36
(Export of alumina)	15	21	14	10
Aluminium ingots	10	8	13	14
Aluminium sheets (excluding castings and holloware)	15	17	18	15

[1] Bauxite forms a convenient return cargo for Mediterranean colliers, and the freight rates are thereby much reduced.

elsewhere is largely the result of the development of motor-car building; (3) The hollow-ware trade, essentially a post-1918 development, is centred at Birmingham, where it is the logical successor of the decayed cast-iron hollow-ware industry. Of 42 manufacturers listed in a recent issue of Kelly's Directory no less than twenty-seven have their works in Birmingham.

Lead.—With the decline of the home lead-mining industry, and the increase of lead smelting at the rich mines of foreign countries, Britain has lost the high position which she formerly occupied in the lead trade. The ores produced in this country now provide only about four per cent. of the total lead consumed, the remainder being imported chiefly in the form of pig-lead from abroad (see table on p. 428). To a greater extent than most other metals, lead is used in the production of certain chemical compounds as well as in the metallic state. Of these compounds the most important are white lead, red lead, and litharge. They are used in the manufacture of glass, for glazing pottery and earthenware, and for the manufacture of paints and pigments. In the metallic state (when it is soft though tough, flexible and very malleable) lead is made into sheets, pipes, wire, and shot; whilst alloyed with other metals it contributes to the production of type metal (lead and antimony), pewter (lead and tin) and certain kinds of brass. Considering this great variety of uses and also the rather scattered nature of the old-time lead industry (cf. Fig. 207), it is not surprising that the manufacture of lead and its products should be much more widely distributed than most of the other non-ferrous metal trades. The only important lead-smelting establishments based upon locally produced ores are in Derbyshire (near Matlock) and on Deeside in Flintshire (at Bagillt). The establishments on Tyneside which flourished in the days when the Alston Moor mines were at the height of their prosperity have now to rely on imported material; the cessation of Mendip lead mining has similarly left the Bristol works without their original basis.

The most important centres of the lead industry to-day are to be found at the ports where the pig-lead is received. London,[1] Newcastle, Manchester, Bristol, and Glasgow are the most important, but as the raw material is imported in a refined condition, and so leaves little or no waste in manufacturing, numerous inland centres also have works devoted to the manufacture of lead sheets and pipes. About 35–40 per cent. of the pig-lead consumed goes towards the making of sheets and pipes, and a similar quantity is used in the manufacture of shot, type metal, and miscellaneous products. The remainder, or about 20–25 per cent., is employed in the production of white and red lead and litharge.

[1] In 1931 a large works at Northfleet commenced refining pig-lead from the Mount Isa mines in north Queensland.

PRODUCTION OF LEAD
(Thousand Tons)

	1928	1929	1930	1931
Pig lead	9	11	10	11
Lead sheets and pipes	95	100	95	85

Zinc.—As with lead, the home production of zinc ores is now almost negligible, and the bulk of the requirements must be imported. In the case of zinc, however, considerable quantities of ore are still imported from Australia, as well as spelter, and smelting is thus still an important side of the industry. The chief uses of zinc are as follows: (1) We have already seen its importance in the brass industry, of which, with copper, it forms the raw material—about 25 per cent. of the spelter consumed goes towards the making of brass. (2) We have examined in Chapter XVIII its use in galvanising steel sheets—about 55–60 per cent. of the spelter consumption is employed for this purpose. (3) Lastly, like lead, it has many subsidiary uses—in electric batteries and in the zincotype printing process, as well as (in the form of various compounds) for the manufacture of lithopone (used in the making of white rubber goods), in the production of pigments and varnishes, in the dyeing and calico-printing industry, and for medicinal purposes. Whilst zinc working is scattered over many parts of the country, therefore, the existence of a large smelting industry, and the necessity for importing spelter as well are bound to have considerable effect upon its distribution.

The smelting of imported ores (*i.e.* the production of spelter) is carried on chiefly in Swansea, where the industry grew up very largely out of the declining copper trade. At first calamine and blende were imported from abroad or from Flintshire, but now the bulk of the supply consists of Australian concentrates. Bristol [1] (the earliest centre of the spelter trade in the country) and West Hartlepool also have smelting works. The galvanising industry has two branches: the first, allied to the tin-plate trade, deals with corrugated galvanised steel sheets for roofing and fencing purposes (see Chapter XVIII); the second, with which we are concerned here, is independent of the tin-plate industry, and is concerned with the galvanising of steel sheets and their manufacture into articles and wares—cisterns, tanks, dust-bins, chimney cowls, hollow-ware, etc. It is true that some of the corrugated-sheet manufacturers of South Wales, Bristol, and Flintshire also deal in the second branch of the industry, but in the main this trade is concentrated in the Birmingham area and at certain ports. In Birmingham and the Black Country it is an offshoot of the formerly important tin-plate trade in an area which deals largely in zinc for its brass industry.

[1] National Smelting Co. at Avonmouth—erected by the Government during the 1914–18 war.

At Liverpool, Manchester, London, and Glasgow, the localising factors would seem to be (*a*) the port where, in the course of general trade, spelter ingots are most conveniently imported, and (*b*) the presence in the vicinity of a large market for the type of goods produced.

The general working of zinc, apart from galvanising and brass making, is carried on in a large number of towns, but as with most of the non-ferrous metals, the industry is dominated by Birmingham, where over 40 per cent. of the firms engaged in the trade have their headquarters.

PRODUCTION OF SPELTER

(Thousand Tons)

1928	1929	1930	1931	1932	1933	1934	1935	1936
55	58	49	21	27	45	54	63	67

Tin.—Tin is not used in nearly such large quantities as lead and copper, the reason being that it does not enter into commerce in the form of articles made of tin, but is employed chiefly in the tin-plate industry (to the extent of about 60 per cent. of the total consumption), in the manufacture of numerous alloys, such as bronze (tin and copper) (*vide infra*) and its varieties—bell-metal and gun-metal, Britannia metal [1] (tin and antimony) and pewter (tin and lead), and in the formation of a number of useful chemical compounds, used especially in the dyeing and calico-printing industries.

Since the Cornish tin mines, like most other non-ferrous metal mines in Britain, now provide only a very small proportion of the total requirements, a large import of concentrates and metal bars is necessary. The tin-smelting industry is located chiefly at Liverpool (Bootle), but there is also a works at Northfleet, on the Thames below London. It is doubtful whether the Cornish smelters at Redruth will ever work again.

Much of the bar tin imported is consumed in the tin-plate industry of South Wales (cf. Chapter XVIII). The bronze industry is dealt with below.

Copper.—Copper was probably the first metal ever adapted by man for his own uses—but its importance in human affairs is now greater than ever before, owing to the part which it plays in the transmission of electrical energy. The valuable properties of copper are its great tensile strength, its ductility, which permits it to be drawn out into the finest of wires, and its capacity for conducting an electric current.

All the copper used in this country now has to be imported, and in consequence the location of the industry is but an interesting reminder of bygone conditions. The early copper industries were founded on such sound geographical bases, however, that the

[1] Britannia metal is largely used in the manufacture of Sheffield plate.

industrial inertia which they have accumulated has sufficed to maintain them, the only alterations being the substitution of refining for ore smelting, and perhaps some change in the nature of the output.

The smelting and refining of matte (half smelted copper) [1] is carried on in those two regions which were formerly dominant in the ore-smelting industry—south-west Lancashire and South Wales, Widnes and Port Talbot being the chief centres, Birmingham and Walsall also having smelting works. The refining and working up of imported copper bars and their transformation into rolled sheets and wire is an industry located mainly in South Lancashire (Widnes, St. Helens, Prescot,[2] Garston (Liverpool))—note the connection with the electrical machinery and cable industries—but several other places, such as Swansea, Glasgow, Hebburn-on-Tyne, Birmingham, Walsall, and Leeds, also share in this branch. About 50 per cent. of the total consumption of copper is employed in the production of wire, and another 25 per cent. in the manufacture of plates and sheets. The manufacture of copper tubes for boilers employs about 10 per cent. of the copper consumption. As far back as the 'sixties some 8,000–9,000 tons of tubes were being produced annually, and the growth of railways and steamships increased this quantity materially before the end of the century. The use of the superheater and of higher boiler pressures, within the last twenty years, however, with the employment of steel tubes, has done much damage to this section of the trade; and the demand for copper fire-boxes has likewise decreased with the substitution of steel. The tube industry is concentrated almost entirely upon Birmingham, where Boulton and Watt first began to produce steam engines on an economic scale in 1775.

Copper is second only to iron as a metal useful to industry, and of the immense variety of articles that can be stamped, pressed, or otherwise fabricated from copper sheets and bars, the electrical and the machinery industries employ the largest proportion. We may expect the "coppersmith" trade to be located, therefore, with special reference to these industries (cf. Chapter XVIII) and it is not surprising that, as judged by the number of establishments, Manchester and Glasgow, the two greatest engineering cities in the country, should head the list. London, Birmingham, Liverpool, Sheffield, the textile engineering towns of the West Riding and south-east Lancashire, and the Tyneside towns are also important—

[1] Copper smelting is a more complicated process than iron smelting. The ore is roasted and once smelted to get rid of most of the sulphur (hence the sulphurous fumes mentioned above) and in this stage it is known as "matte" or "regulus"; a further roasting follows, and then another smelting, when the copper is ready for a final electrolytic refining.

[2] A new works was opened at Prescot in 1933 for the working of copper of great purity from the Roan Antelope mine in Northern Rhodesia.

but the industry, like general engineering, is on the whole very scattered.

PRODUCTION OF COPPER
(Thousand Tons)

	1928	1929	1930	1931
Copper ingots	15	17	17	16
Copper sheets, rods, tubes, and wire	100	105	91	85

The Alloys.—Alloys are mixtures of two or more metals designed to give physical properties different from those of the metals which compose them. Some of these have already been referred to. The most important groups are the brasses and bronzes.

Brass.—Brass is the name given to a whole series of copper-zinc alloys, containing over 50 per cent. of copper, the mixing of the metals in different proportions creating new metals of varying properties. Brass, like copper, will take on a brilliant polish, and has a similar high tensile strength, but it is harder than copper. Of the many different varieties in common use, the following may be cited as examples: "yellow metal" for hot stamping is 58 : 40 with a little lead; Muntz's metal, a malleable variety, is 60 : 40; brass for wire 70 : 30; "naval" brass 61 : 38, with a little tin to improve its corrosion-resisting property. It may be as well to remind ourselves of the many ways in which brass enters into commerce and industry. The brass trade falls naturally into two sections: (1) the actual making of the alloy and the production of semi-manufactured material. Of an annual production of something over 100,000 tons, about 80 per cent. is in the form of rods and sheets (the raw material of the foundry and stamping branches) about 12 per cent. is brass wire, and about eight per cent. in the form of tubes (for boilers, bedsteads, and curtain rods); (2) the finished goods section, comprising cabinet brassfoundry (hinges, knobs, etc.), lighting (oil lamps, gas, and electric-light fittings), plumbers' brassfoundry (taps, etc.), engineers' brassfoundry (steam cocks, whistles, etc.) naval brassfoundry, and a host of general products, such as picture rails and nails.

The brass industry has many times, with changing fashions, been called upon to turn to new activities, and usually the decline of one branch has been accompanied or followed by the rise of another. This has been especially evident during the present century. The declining demand for the elaborate gas fittings, ornamental candle-sticks, brass-railed bedsteads, and brass hearth furniture of the Victorian era has been offset by the rise of the electrical and motor-car industries, both of which are great brass users, and by the great post-1918 development of housing schemes with their accompanying need for "builders' brassfoundry" (locks, hinges, knobs, rails, and so on).

The whole of the brass industry is dominated by Birmingham. At the 1931 census, of 40,000 people employed in the making of brass and brass-ware, over 16,000 were enumerated in that city, whilst several thousands more were not far away in Smethwick and other Black Country towns. Outside the Birmingham region, the various branches of the brass trade are very widely scattered all over the country, most important towns, and many quite unimportant ones, having some establishment, possibly a huge factory or possibly only a small workshop, dealing with one or another type of product. Much of the heavy brass industry, together with naval brassfoundry, has migrated northwards to the engineering and shipbuilding centres, leaving Birmingham to specialise upon the innumerable smaller foundry and stamped products. Thus whilst Birmingham had only 30 per cent. of the brassfoundry workers in 1931, it claimed 62 per cent. of the workers employed in the manufacture of light brass goods (builders' accessories, etc.). The rapid development of bakelite and stainless steel has had a very serious effect on the latter branch. In 1921 it employed 24,000 people; in 1931 only 12,000. The numerous engineering industries of London employ some 2,000 brassworkers, and Manchester, Glasgow, Wolverhampton, Liverpool, Leeds, Huddersfield, Sheffield, Rotherham, Newcastle, and Bristol—to name only a few—are amongst the most important provincial centres of the brass trade.

Bronze.—Bronze was the first alloy ever made. Although it is no longer the chief metal for ornaments, utensils, and weapons, certain types of bronze still play an important part in industry and art. Bronzes are harder, stronger, and more durable than copper or brass, and are particularly resistant to the effects of atmospheric weathering. In industry, bronzes are employed for machinery bearings, pumps, boiler-mountings, valves, and cocks, and for parts exposed to damp air or water; and in the arts, bronze is almost unrivalled for beauty of finish and general appearance in the production of statuary and ornaments. In general, bronzes are made up of about 80 per cent. copper, and 20 per cent. tin; gun-metal (so called because it was formerly a favourite material for the making of cannon) has more copper, and more recent varieties which give extra strength and toughness, combined with an even greater resistance to corrosion, are phosphor bronze (containing some lead and a little phosphorus) and manganese bronze (with a little manganese and iron).

The chief centres of the bronze industry are Birmingham and London. Other towns of importance are Manchester, Coventry, and Glasgow (note the correlation with the engineering and motor industries), and Sheffield, where the industry is one of many con-concerned with non-ferrous metals (especially the rarer ones). The numerous other centres are scattered, and no geographical explanation can be given of them.

Other Metals.—Antimony, chromium, molybdenum, tungsten, and a number of other rarer metals are imported into this country in small quantities for special purposes—usually for alloying with other non-ferrous metals or with steel. Antimony is used, largely by reason of its hardness and resistance to corrosion, in Britannia metal and type metal; chromium, molybdenum, and tungsten are chiefly employed at Sheffield for the production of special quality steels—chromium for rustless steel [1] and steels of high-tensile strength, molybdenum for high-speed tool steels, tungsten for very hard steels (and also for wire in incandescent electric lamps). These metals are refined either at Sheffield, where their subsequent employment lies, or in South Lancashire (Widnes and St. Helens). The most important of the other metals, however, is nickel. Nickel matte from Canada is refined at Clydach (Swansea), and the resulting metal is employed in the manufacture of nickel-silver at Sheffield and Birmingham, and in the production of nickel-steel, a high-tensile variety, at Sheffield. An interesting by-product obtained at Swansea is copper sulphate (the nickel matte contains copper) exported to Mediterranean countries for vine spraying, and to Ireland for potato spraying.[2]

The Precious Metals.—Although gold and silver ores have never been worked in any great quantity in Britain, the unceasing demand for plate, ornaments, and jewellery has given rise to a flourishing industry based upon imported supplies of these precious metals. In 1931, over 30,000 people found employment in the jewellery, precious metal working, and plate trades. This section of the non-ferrous metal industry is far more concentrated on a few localities than any of the trades devoted to the baser metals. Birmingham, Sheffield, and London are the only cities in which the precious metals are utilised to any extent. Avoiding details, it may be said that Birmingham largely controls the refining and beating of gold, and the manufacture of gold chains and other jewellery, whilst silver and the electro-plating trades are divided between that city and Sheffield. The Sheffield silver-plate industry dates from about 1740, when Thomas Bolsover discovered a method of coating a copper ingot with silver in such a manner that it could be subsequently rolled and worked into plate and ornaments. The growth of the silver and electro-plating trades in Sheffield (the latter from 1840) is partly the result of this almost accidental beginning, and is partly, no doubt, to be ascribed to the availability of labour already skilled in the working of metals. Finally, London, largely by reason of its immense potential market, shares in all the chief branches of the gold and silver industry.

[1] Notice also the amazingly rapid recent growth of chromium plating.

[2] Production of copper sulphate (average, 1928–31), 44,000 tons. Export of copper sulphate (average, 1928–31), 43,000 tons.

An attempt may now be made to summarise the non-ferrous metal industries according to the regions of Britain where they are carried on.

In 1931, nearly 150,000 people were employed in Great Britain in industries concerned entirely, or almost entirely, with non-ferrous metals, and there were in addition some 30,000 unemployed in the same trades. Of those in employment, no less than 49 per cent. were in Birmingham and the Black Country, 16 per cent. in the London district, 13 per cent. in the West Riding, and 8 per cent. in South Lancashire.

Although many branches, as we have seen, are very scattered in their distribution, the non-ferrous metal industry as a whole falls, geographically, into a number of fairly well defined provinces, each characterised by the presence of a different series of trades.

The *Birmingham District* is probably the greatest metal-working area in the whole world. Employing nearly 75,000 people, it engages in almost every possible activity connected with non-ferrous metals, from smelting and refining, through the production of semi-manufactured material to the fabrication of innumerable varieties of finished goods. Its specialities, however, are the making of brass, the rolling of brass and copper, and the manufacture of tubes, the production of all kinds of cast and stamped copper and brass-foundry, the working of gold, and the manufacture of gold, silver, and electro-plated ware, and the production of aluminium hollow-ware.

The *London District*, including lower Thames-side, also has a great variety of metal trades, owing to the facility for importing raw materials and the extensive market provided by the eight millions of people in the conurbation. Northfleet has important tin and lead-refining works, and London itself, principally in the East End and also south of the Thames, engages in the jewellery trades, sheet-metal working of all kinds, brass and copper foundry, bronze manufacture, galvanising, and the manufacture of lead, and lead products.[1]

The *West Riding* assumes a position of importance, largely by reason of the part played by Sheffield in the manufacture of silver ware and electro-plated goods. The baser metals are also worked to a considerable extent, however, notably copper and brass—these industries, located mainly in the towns which make up the West Riding conurbation, as well as in Sheffield, being dependent upon and auxiliary to, the great engineering industries of that region.

South Lancashire has two sides to its industry. In the western part of the region, at Liverpool, Widnes, and St. Helens, are located the smelting and refining branches, together with rolling and wire

[1] Billiter Street, in London (bellyeter = bell-founder) was a former centre of the bell-founding trade. London has 300 foundries dealing with non-ferrous metals.

drawing, the chief metals dealt with being copper, tin, and aluminium. The eastern part of the region, however, is more concerned with copper and brassfoundry as a part of the great engineering industry of Manchester and the other towns that have been mentioned in Chapter XVIII.

In *South Wales* we find all that remains of the once world-famous smelting industry. In the Swansea-Port Talbot area are the principal zinc and nickel smelters in the country and the last remnant of the Welsh copper-smelting trade. It is a good reflection upon the geographical environment of South Wales, however, that just as in the iron trade, few or no derived industries should have been set up. The absence of a great engineering industry has rendered impossible the growth of extensive foundry trades, and even rolling and wire drawing are conspicuous by their absence or feeble development. The smelting and refining industries at Bristol may be considered, having similar geographical bases, as an outlier of the South Wales province.

The *North-east Coast* still retains its interest in the smelting business, lead and zinc being produced from materials which now have to be imported. The brass and copper industries are largely bound up with the engineering and shipbuilding trades, being concerned primarily with the requirements of the shipyards, and the marine and locomotive engineers.

On *Clydeside* the non-ferrous metal industries are mainly dependent upon the engineering and shipbuilding trades, but they also owe their development partly, as at other large ports, to the facility for importing raw materials. Copper and brassfoundry, sheet-metal work, jewellery, and galvanising are the most important branches.

EMPLOYMENT IN NON-FERROUS METAL INDUSTRIES, 1931 [1]
(In Thousands)

Area	Smelting; refining	Foundry	Rolling; tubes	Brass-work	Sheet metal	Jewellery and plate	Total
Scotland	1·8	2·3	0·3	0·1	1·5	0·4	6·4
North-East . . .	0·8	0·5	0·1	0·0	0·5	0·1	2·1
Lancs. & Cheshire .	2·6	2·4	1·0	0·4	4·3	0·9	11·6
W. Riding . . .	0·3	5·2	1·3	1·1	2·4	8·5	18·9
W. Midlands . .	2·7	17·1	11·7	8·9	17·2	14·8	72·4
E. Midlands . . .	0·1	0·7	0·1	0·0	1·0	0·2	2·1
S. Wales	2·6	0·1	0·0	0·1	0·3	0·0	3·1
South-East . . .	3·0	4·9	1·2	1·6	9·6	7·2	27·5
(Greater London) .	*2·5*	*4·4*	*1·1*	*1·5*	*7·8*	*6·5*	*24·0*
Total persons employed . . .	14·3	33·8	16·1	12·4	38·1	32·7	147·5
Unemployed . .	4·7	8·2	3·1	2·5	6·8	5·2	30·6
Total, 1921 . . .	19·5	32·5	16·1	24·2	35·7	52·5	181·6

[1] Compare table on p. 410, in which the same regional divisions are presented.

EXPORTS OF NON-FERROUS METALS AND MANUFACTURES THEREOF
(Thousand Tons)

Metal	1913	Average 1921–25	Average 1926–30	1931	1932	1933	1934	1935
Aluminium	—	5·9	9·6	6·8	7·2	8·5	7·1	7·9
Brass	13·4	26·2	21·3	12·1	17·7	22·6	29·2	25·9
Copper	63·4	32·3	33·7	19·4	16·4	23·0	25·0	38·9
Lead	48·4	18·0	12·2	9·3	8·8	10·8	12·1	12·0
Nickel	—	4·6	7·8	4·8	3·9	5·9	8·6	11·7
Tin	11·5	18·8	29·3	25·0	15·7	32·0	19·5	25·4
Zinc	11·1	6·3	6·5	6·5	6·6	6·0	7·7	9·0
White Metal . . .	—	6·9	4·0	3·8	2·3	2·4	2·9	3·9
Total value (Million £'s)	12·0	14·4	17·2	6·9	6·9	12·1	11·9	14·1

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CHAPTER XX

THE TEXTILE INDUSTRIES: WOOLLEN AND WORSTED[1]

The Textile Industries: General

THE textile industries, which for many centuries have been the mainstay of British prosperity, are well supplied with literature, technical and historical, economic and geographical. In this and the following chapters little more can be attempted than a summary of the main features of their development, present distribution, and relative importance.

Not only are the textile industries of vital importance as employing nearly a million people, and as being the source of about 20 per cent. by value of British trade, but they also provide interesting examples of the factors influencing the localisation of industry and the alterations in distribution brought about by changes in geographical values. These changing values are concerned primarily with the development of machinery and sources of power supply, and with the relative part played by the various kinds of raw material.

Although wool was from time immemorial the principal fibre employed in the making of cloth, the cotton industry, only introduced into Britain in the seventeenth century and not really important until the second half of the eighteenth, has long since surpassed the woollen in size; and whereas the making of woollen cloth, formerly a very scattered trade based upon local raw materials and still carried on in a number of different areas, has suffered radical changes in its geographical distribution, the cotton industry, never very widespread and always using imported fibre, has been localised very largely in the region of its origin. Of the industries based upon the minor textile fibres, whilst those of long standing, such as linen and hemp, show very definite localisation upon home sources of raw material, the newer introduction, artificial silk, has merely attached itself as a satellite to the older trades in regions where a " deposit " of labour skilled in the working of textiles had accumulated.

[1] By S. H. Beaver. The authors are greatly indebted to their colleague, Mr. H. L. Beales, for his valued comments and criticism on this chapter.

the country, which, largely owing to their accessibility from the Continent and from the Metropolis, were at that time the seat of the chief economic developments. The earliest recorded weavers' guilds, for example, grew up in London, Winchester, Lincoln, and Oxford, and other towns which gained a reputation for fine wares were York, Beverley, Colchester, and Sudbury. Although the making of cloth was widespread, however, the industry was probably of no great magnitude, and most of the wool from the English sheep was exported in a raw state to the Continent.

(*b*) *The first economic revolution, fourteenth to sixteenth centuries.*—Having reached a peak of production and export in the thirteenth century, the wool trade declined for a long period; the almost incessant political strife was not conducive to its expansion, and many formerly important centres decayed. The seeds of a new period of progress were sown in the fourteenth century, however, when, from 1331 onwards, small bands of skilled craftsmen from Flanders were encouraged to settle in various parts of the country Numerous weavers, dyers, and fullers settled in large towns where the woollen industry was already in existence—such as London, York, Winchester, and Norwich—or scattered themselves over the countryside. The widespread possibilities for cloth-making were largely due to the suitability of such large areas of the countryside for sheep rearing (although from the earliest times the drier limestone and chalk uplands seem to have been the chief regions), and the absence of other localising influences. Water-mills were only just coming into use for working the fulling hammers, and not only was the power required so small that almost any stream would do, but the unfinished cloth could be, and indeed was, sent from scattered weavers' houses to the small streamside establishment of the fuller.[1]

The export trade in wool recovered; it was largely a seasonal trade, for before the introduction of root crops as fodder, large numbers of animals had to be slaughtered in the autumn. Thus in the summer the shorn wool was sent across the Channel, in the autumn and winter the "fells"—skins with wool still adhering thereto. But manufacturing expanded as well, and gradually the cloth industry began to be more localised and rather more specialised. The need for soft, lime-free water for the washing, scouring, and dyeing processes, combined with the increasing use of water power for the fulling mills, resulted in certain regions offering a more than usually favourable environment for the industry. In Gloucestershire, Somerset, and Wiltshire, the importance of the sandstone formations in the Jurassic series, as suppliers of soft water, and the existence of a dissected scarp,

[1] The need of pure water for dyeing was not apparent whilst most of the cloth was exported in a "grey" state to be finished in Flanders.

providing numerous power sites, together with the extensive sheep pastures on the Cotswolds and in Herefordshire, were favourable factors. In Devonshire a number of centres grew up on the outer edges of the Dartmoor mass, favoured by soft water from the granites or culm measures and a useful power supply. In the Pennine districts of Yorkshire and Lancashire the soft water from the Millstone Grit Uplands, and the numerous steeply-graded streams, gave plenty of scope for development. In East Anglia, where many of the Flemish weavers settled, much soft water was available from the Boulder Clay streams, but little or no power. As a result this region was not so well fitted for the production of true woollen goods, and came early to specialise in the manufacture of worsteds.[1] The idea of the fulling operation was to felt the cloth by pounding it with hammers in water mixed with soap or fuller's earth, and as worsted fabrics made from longer and finer wools did not require this treatment, power was not necessary. Of these four areas the two in the west of England were producing, at the end of the fifteenth century, about one-third of the woollen cloth made in England, East Anglia was responsible for about a quarter and Yorkshire for one-eighth (mainly of poor quality), and, in addition, East Anglia produced almost all the worsted material. Finally, it is very noticeable that the sheep-rearing regions of the Jurassic scarplands where limestone is a dominant formation and the stream water consequently hard—*e.g.* Lincolnshire and Northamptonshire—did not develop the manufacture of woollen fabrics to any great extent.

Thus during this period the whole economic outlook of the country was changed, and from being primarily an exporter of raw wool England became in addition a manufacturer and exporter of cloth. The end of the fifteenth century saw England "largely a nation of sheep-farmers and cloth-makers." The wealth derived from the wool trade was spent in church building and road-making, and many a fine church and cathedral and many a now-ruined abbey owes its origin to the sheep. The monks especially were great sheep farmers, as the records of the many old abbeys of Yorkshire bear witness.

(*c*) *Growth and expansion, sixteenth to eighteenth centuries.*—The expansion of the woollen and worsted industries brought about an increasing specialisation: (*a*) of different regions in different classes of goods; (*b*) of individual members of a manufacturing community in different processes; and it also contributed to the rise of a new class in society—the "clothiers" or "drapers" who purchased raw wool from the farmers, gave it out to the spinners and weavers to be made into cloth, and then sold the finished pieces

[1] It is generally agreed that the name "worsted" is derived from the little village of Worstead, not far from Norwich, one of the earliest centres of the industry.

in local markets or at the London Cloth Fair.[1] Much of the wealth gained by the drapers, and by the companies which they formed, went not into ecclesiastical channels but towards the further expansion of industry and trade. Then political and religious troubles on the Continent were continually interfering with the Flemish cloth industry, and from time to time bands of refugees would flee their country and settle in England. In the sixteenth century, for example, after the revocation of the Edict of Nantes, a large body of Huguenots arrived from France and took up their abode in various cloth-making regions, notably in the Stroud area of Gloucestershire. As a result, the English cloth trade began to surpass that of Flanders, and at the end of the seventeenth century woollen manufactures made up two-thirds by value of England's export trade.

We must pause to analyse in a little more detail the geographical background of the principal centres of the industry in the seventeenth and early eighteenth centuries.

1. *The West Country.*[2]—Within the region so designated there were two distinct producing districts, the Cotswold area (extending from Cirencester to Sherborne, and from Devizes to Bristol), and Devonshire. In Gloucestershire, Wiltshire, and part of Somerset was concentrated the manufacture of the famous "broadcloths," whilst Devonshire and south-western Somerset specialised in serges. The geographical advantages possessed by the region as a whole may be summed up as follows:

(1) The agricultural wealth of the fertile vales and the pastoral wealth of the uplands had long been utilised and had given rise in quite early times to a comparatively dense population.

(2) Supplies of raw materials—long-woolled sheep of Dartmoor and the Cotswolds (for the serge industry), short-woolled sheep of the near-by chalk uplands and the rich lands of Herefordshire, of the Forest of Dean and of Exmoor—and fuller's earth from the local "Fuller's Earth" formation, which is particularly well developed on the dip-slope of the Cotswolds—were present in abundance.

(3) When the necessity arrived, the geographical situation for the import of foreign wool was distinctly favourable—and Barnstaple and Bristol imported long wools from Ireland and fine merino wool from Spain.

(4) The abundance of soft water,[3] which was particularly

[1] The markets were known as "Cloth Halls"—*e.g.* Blackwell Hall in London.

[2] See R. H. Kinvig: "Historical Geography of the West Country Woollen Industry." *Geographical Teacher*, VIII, 1916, pp. 243–54; 290–302.

[3] Although much of the Cotswold dip-slope plateau is composed of shelly limestone (known as "calcareous grit"), the chief water-bearing bed in the Scarp region is the Cotswold (or Midford) Sand, which yields copious supplies, having a very low degree of permanent hardness.

suitable for dyeing, and of small water-power sites, as mentioned above, rendered the localisation complete.

Broadcloth was, perhaps, the finest variety of woollen fabric ever produced. It was made from the best short wools (*i.e.* not from the local Cotswold sheep) and was heavily fulled and felted so that when finished the weave was quite invisible. It was used for uniforms, liveries, and the best class of clothing. The wearing of broadcloth was formerly the mark of a gentleman. The importance of a power supply for the fulling is very evident, and it is not

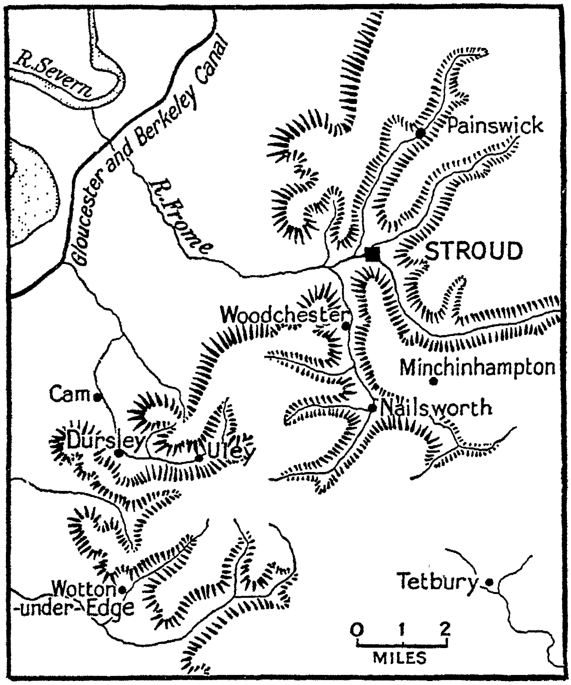

FIG. 208.—The Broadcloth Region in the dissected scarpland of the Cotswolds.

surprising that with the growth of the industry the localisation became more definite, and the network of "clothing towns" and "clothing villages" which Leland describes became more concentrated. The early town centres, Gloucester, Bristol, and Tewkesbury, soon declined, and the less suitable outlying centres as, for example, the villages along the chalk scarp (Devizes, Warminster); those on the Mendip fringe (Frome, Wells); those on the Jurassic scarp of Somerset (Bruton, Castle Cary) and those in the Avon valley (Chippenham, Melksham, Bradford) decreased in importance or became specialised. Wells, for example, took up the hosiery trade; Frome specialised in fine Spanish cloths. It was on the dissected west-facing scarp of the Cotswolds that the industry

became concentrated, and the old centres on the dip-slope—Tetbury, Cirencester, and Witney, all had to specialise to avoid extinction. Thus Tetbury, devoid of water power (almost, in fact, devoid of water) took up wool-combing and spinning, and Cirencester did likewise—thin yarn from the long-woolled Cotswold sheep being sent to the hosiery and worsted centres. Witney, partly perhaps owing to a peculiarity of the Windrush water which makes it well suited to the bleaching operation and partly to the fact that it had little or no power, specialised in blankets which are made from short wool and fells and do not need heavy milling. On the western slope of the Cotswolds the deeply cut valleys of the Frome and its tributaries contained numerous centres of the industry—Stroud, Painswick, Minchinhampton, Woodchester, and Nailsworth, and a little further south the edges of a westerly projection of the scarp provided power sites, for example, at Dursley, Wotton-under-Edge, and Uley (Fig. 208). The waters of the scarp were considered to possess some property which rendered them particularly suitable for the production of the fine scarlet dye for which Gloucestershire cloths were famed.

"Serge" was the name given to a fabric made with a warp (longitudinal threads) of long wool, and a weft (crosswise threads) of short wool (or of the short combings derived from the long wool). Both long (Dartmoor) and short (Exmoor) wools were available in Devonshire, and in addition much long Irish wool was imported *via* Barnstaple and other ports, and short wool from Kent and Sussex, *via* Exeter. Water power was necessary for milling serges, as for broadcloths, and the numerous small streams radiating from the Dartmoor massif supplied this in plenty. But owing to the comparative isolation of the individual streams many small manufacturing centres grew up, and there was no concentration as at Stroud. Ashburton, Buckfastleigh, Tavistock, Okehampton, North and South Molton, Tiverton, and Crediton may be cited as examples, whilst just over the border, in Somerset, Taunton and Wellington were also engaged in the serge trade (Fig. 209). The great market for all this industry was Exeter, which in the eighteenth century rivalled Leeds in this respect.[1]

2. *East Anglia*, lacking water power, obviously could not produce broadcloths and serges, and in consequence it was the worsted trade which flourished here. The world-wide fame to which this region attained in the seventeenth and eighteenth centuries was in large measure due to the presence of the Flemish weavers and their descendants—for far more artistic skill was necessary for the production of patterned worsteds than for the making and finishing of plain broadcloths. Two separate districts were engaged in the

[1] See W. G. Hoskins: *Industry, Trade and People in Exeter*, 1688–1800. Manchester Univ. Press, 1935. Chap. II gives an account of the serge industry, which about 1700 was the most important branch of the national woollen manufacture, accounting for over a quarter of the total exports.

trade. Norwich, once the greatest manufacturing town in all England,[1] was the centre of a whole group of flourishing towns and villages engaged in the production of fine worsteds: for example, Thetford, Diss, Dereham, and Attleborough. In Suffolk and Essex a number of towns in or near the Stour valley, the largest of which were Colchester, Sudbury, and Halstead, had a two-fold interest. Besides making some worsteds, and doing a great deal of combing

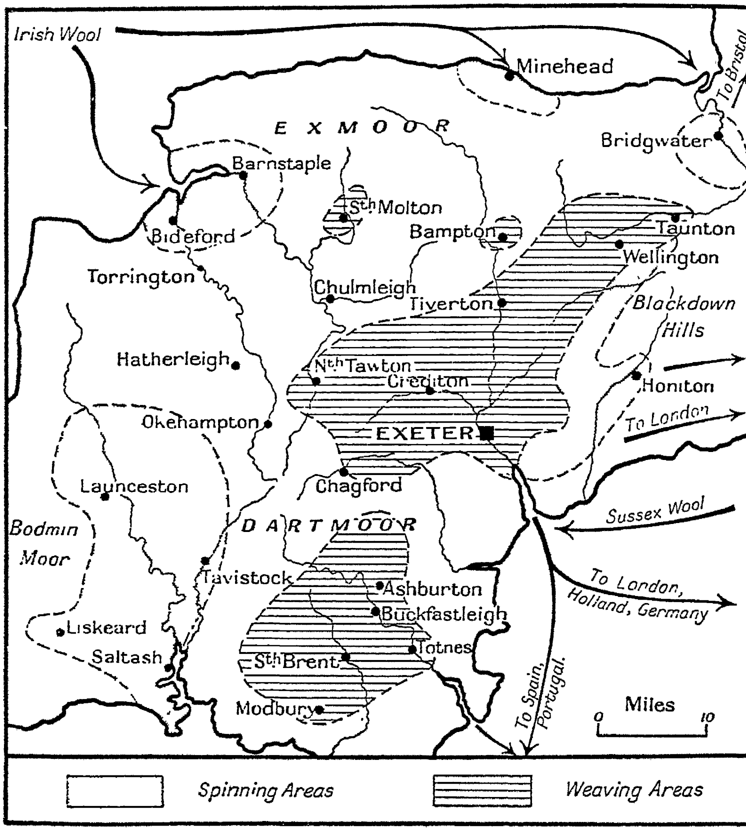

FIG. 209.—The West Country Woollen Industry about 1700. (Mainly after Hoskins.)

and spinning for the Norwich weavers, this region, largely owing to the presence of a small amount of water power provided by the Stour and its tributaries, was devoted to the production of coarse cloths made from short wools—baize and kerseys, which were not true woollens, but rough loose fabrics which did not need much milling.

For 400 years East Anglia possessed a virtual monopoly of the worsted trade, and not until the beginning of the eighteenth century did a rival appear in the West Riding of Yorkshire.

[1] In 1770, no less than 72,000 people were employed.

3. *Yorkshire and Lancashire.*—The gradual rise of the north country in the woollen trade is to be associated with the natural suitability of the Pennine Uplands for sheep rearing, the abundance of lime-free water, and the existence of innumerable possible sites for waterwheels. The sixteenth century spread of the industry up the valleys was also due to a country-ward movement of the craftsmen away from the guild-fettered corporate towns of the lowlands.[1] We must not neglect the fact, also, that a good deal of energy behind the expansion of the industry came from the Nonconformists, whose Puritanism with its insistence on the duty of work, its teaching that business could be a "divine calling," and its inculcation of the virtues of prudence, probity, and economy which smoothed the path to riches, was largely responsible for their accumulation of capital and its application to the development of trade. In both Lancashire and Yorkshire the early industry, devoted to the weaving of coarse woollen cloths called "kerseys," clung to the upper parts of the valleys, the dwellings where the spinning and weaving were done being situated on the slopes and higher parts (since surface water is very abundant on the Millstone Grit formation and Lower Coal Measures), the fulling mills in the valley bottoms by the larger streams. It was essentially a rural organisation—a combination of domestic industry and agriculture for the home food supply, where each house had its own cultivated patch and urban centres were not developed to any great extent.[2] The industry quickly outgrew the local wool supplies, and the Lancashire region began to import from Ireland and from the Midlands, whilst the West Riding came to rely more on Lincoln and Leicester wool. About the end of the sixteenth century, the manufacture of baize (using woollen warp and worsted weft) was introduced; but as the use of cotton began to spread soon afterwards in South Lancashire, the woollen trades in that area were pushed farther and farther eastwards until the Rochdale neighbourhood was the only important district remaining. Then, early in the eighteenth century, the wealthy merchants began to introduce the manufacture of worsted material, and Halifax and Rochdale quickly took to the making of "shalloons" (light worsted cloth for dresses and linings)—the older baize trade gradually dying or being replaced by the weaving of flannels. By the 1770's the output of worsted cloth from the West Riding equalled that of Norwich, but the Yorkshire worsteds were mostly of much poorer quality.

An important auxiliary industry in the West Riding was the manufacture of wool-cards—stiff wire brushes used for opening out

[1] Of the great West Riding towns, only Wakefield ever harboured the guild system. The serious decline of York at this period is well known.

[2] See the illuminating description in Defoe's *Tour through the Island of Great Britain* (which covers the years 1724–1727).

the wool and interlacing the fibres as a preparatory to spinning.[1] This was located at Brighouse—attracted thither by the old iron forge at Colne Bridge (near the outcrop of the sulphur-free " Better Bed " coal and near a formerly important seam of ironstone).

In the eighteenth century the main outline of the great conurbation was complete; Leeds, Bradford, Halifax, Huddersfield, and Wakefield were flourishing towns, Leeds and Wakefield having large cloth markets. Bradford had, however, not yet assumed special prominence.

4. Mention must finally be made of a few other isolated and rather specialised centres of the woollen industry. Worcester and Kidderminster were really outlying centres of the West Country broadcloth trade. Kendal, in Westmorland, was long famous for " Kendal cottons " (not made from cotton, but from local wool). In Leicestershire the local long-woolled flocks gave rise to a small woollen industry as early as the thirteenth century: and in the seventeenth century a domestic hosiery industry became established.

In the first half of the eighteenth century we thus see the woollen and worsted industries considerably more specialised and concentrated upon a few areas than they had ever been before. The West Country and East Anglia had almost reached their peak of prosperity, but the West Riding was really only just beginning to be of real importance in the manufacture of any but the poorest cloths. All this was about to be changed, for with the introduction of machinery and the utilisation of steam power and so of coal, the whole basis of the industry was radically transformed.

(*d*) *The Industrial Revolution*, 1750–1850.—The domestic processes of cloth manufacture had been little changed since the great revival of industry in the fourteenth century, and consequently the inventions which we have now to discuss produced an upheaval of unparalleled magnitude. This upheaval, however, took place earlier and was far more sudden in the case of the Lancashire cotton industry than with the Yorkshire woollen and worsted trades: in the first place because almost all the inventions emanated from Lancashire; secondly, because the woollen fibre did not lend itself so readily to being worked by fast-moving machinery, and thirdly, because an adequate supply of raw wool was not easy to obtain until Australian produce became available after about 1830. The history of these inventions is an oft-told tale, and a very brief summary must here suffice. In 1733 John Kay introduced the flying shuttle, thus rendering the process of weaving rather more rapid. This was perhaps a little unfortunate, for already it took ten spinners to keep one weaver supplied with yarn (a fact which is reflected in the large number of women who were engaged in spinning

[1] The name " card " is derived from Latin *carduus* = a thistle or teazel, since teazel heads were used in the carding process.

—and thus in the retention of the term "spinster" for an unmarried woman); in the 'seventies, however, Hargreaves' Spinning Jenny and Arkwright's roller-spinning machine, remedied this state of affairs, and the application of water power to the latter resulted in such an increased output that a surplus of yarn was produced. The application of mechanical power to weaving was somewhat delayed (*vide infra*). All these inventions were applied first to the cotton industry and their adaptation to wool and worsted came later. As a result the "water-power" stage in the West Riding was not of long duration and in some cases did not exist at all—for by the time machinery was introduced on a large scale, the steam engine had been sufficiently perfected as to be the obvious source of power for new mills and new machines. A new control—the existence of productive coal measures—entered the field.

The Lancashire inventions gradually crossed the Pennines and worked their way into the West Riding from the south-west, *via* Huddersfield and Halifax, and probably by 1780 the use of the spinning jenny, still worked by hand, and of the scribbling machine (performing part of the carding process), worked by water power, had spread over most of the region. Neither of these could produce much change in the industry apart from a speeding up of certain of its processes—and by the separation of the upland, domestic, spinning and weaving from the valley-bottom scouring, fulling, and carding, much wasteful carriage had to be performed, each piece of wool journeying several times up and downhill before it finally emerged as a finished cloth. From 1785 onwards Watt's steam engine began to be used in the mills of Lancashire and Nottinghamshire, and the first in Yorkshire was set up for driving, scribbling, and fulling plant at Leeds in 1792 [1]—marking the beginning of the end of the short reign of water power. Spinning machinery was introduced into Yorkshire in the 'nineties, and was in fairly general use by about 1810—the quick change-over being due possibly to the large numbers of women and children employed who were unable, like their men-folk, strenuously to resist the introduction of mechanical appliances. It must be noted, however, that it was the worsted branch, in which the longer, silkier fibres were more adaptable to mechanical handling, that progressed most, little headway being made with spinning machinery in the woollen branch until after 1830. Other, more commercial, reasons for the greater mechanisation of the worsted industry, were the greater capitalisation and more efficient organisation (it being a younger industry and essentially the product of Yorkshire's own accumulated wealth) and the large "outside" demand (from the East Anglian worsted trade and the hosiery trades) for worsted yarn. The introduction of power looms took a much longer time, partly owing

[1] See *Leeds Woollen Industry*, 1780–1820. Editor, W. B. Crump.

to the technical difficulty already alluded to and partly owing to vigorous opposition from the hand-loom weavers. Not, in fact, until the early thirties was real progress made, but by 1835 Yorkshire possessed over 4,000 woollen and worsted power looms out of a total for the country of about 5,400 (a further 1,100 being only just across the Pennines in Lancashire).[1] Gig mills (rotating drums set with teazels for raising the nap on cloth) and shearing frames (for cropping the nap) were also introduced fairly late, and the famous Luddite Riots of 1812 were largely directed against their use. In the following decade, however, they were erected rapidly in all districts.

Even when, stimulated by the outstanding success of the mechanised cotton industry of Lancashire, the use of machinery was well established, wool continued to lag far behind worsted for reasons given above, and also because there was much less specialisation in the woollen trade, most factories completing all or most of the processes, and a considerable amount of domestic work still taking place. In 1835 the number of looms weaving worsted cloth was four times the number weaving wool, and as late as 1856 only half of all the woollen workers in the West Riding were employed in factories, and hand-loom weavers remained an important section until the 'seventies, not being finally negligible until about 1900.[2]

If the introduction of machinery was slow, though comparatively unobstructed, in the West Riding, it was much more retarded and much more bitterly opposed in the West Country, and in East Anglia the industry died before the machine had time to take root. Both in the West Country and in East Anglia the workers in the ancient industries were well organised and the industry was fairly concentrated, and so a much more effective opposition could be raised to the introduction of labour-saving machinery. This opposition proved their undoing. The swamping of the cloth market by cheap machine-made goods from Yorkshire gave a blow to the older industries from which they have never recovered. The copying by machinery of all the fancy worsted designs of Norwich effectively killed the trade in that town. By 1830 domestic spinning had ceased to exist, and in 1838, when Yorkshire had 347 steam-driven mills employing over 26,000 people, Norwich had three with only 385 workers. The perfection of Arkwright's combing machinery had allowed short wools as well as long to be used for worsted manufacture, and the rapid spread of new fabrics produced by adding cotton, alpaca, or mohair warps to the worsted weft gave

[1] Compare this total with the 114,000 power looms which existed in the cotton industry at the same period.

[2] Persons employed in woollen and worsted factories: 1835, 55,461; 1850, 154,180; 1861, 173,046; 1870, 238,503; 1880, 301,556; 1901, 259,909. Cf. cotton, p. 481.

a tremendous stimulus to the Yorkshire worsted industry, which rapidly outpaced the slower growing woollen trade.

The West Country industry did not feel the pressure of Yorkshire competition so soon as East Anglia, owing to the late introduction of machinery and steam power into the woollen branch, and to the persistence of the domestic system. After 1840, however, the declining market for the fine broadcloths and the inability of the Cotswold industry to adapt itself rapidly to the new conditions, resulted in a period of decline—though the industry was by no means completely extinguished.

The general features of the Industrial Revolution period in the woollen and worsted industries may be summed up as follows :—

(1) A gradual decline of the domestic system, less rapid in wool than in worsted, and in weaving than in spinning : accompanied by the development of large scale production in factories.

(2) A short period of water power quickly followed by the employment of the steam engine for driving machinery

(3) The rapid expansion of industry in the West Riding, where the localisation was confirmed by the presence of coal, which was employed for generating power and for heating and humidifying the mills in accordance with the requirements of the spinning and weaving operations.

(4) The rise to supremacy of worsted over woollen in Yorkshire very largely for technical reasons and owing to the organisation of the worsted industry.

(5) The decline and complete extinction of the Norwich worsted trade and the general decline of the West Country industry where, however, with increasing specialisation the finest woollen cloths continued to be made.

(6) The growth of the West Riding, in combination with the rapid expansion of industry and population in Lancashire (see Chapter XXI), brought about a change in the " centre of gravity " of the English population and an increasing dominance of the north over the south.

(*e*) *Modern Concentration and Development from* 1850.—The essential features in the geography of the woollen and worsted industries have remained unchanged since the great transformation wrought by the Industrial Revolution, and it remains to notice only the more important economic changes which have taken place.[1]

Despite the great increase in the productivity of the industries there has been little expansion since 1850 in the number of people employed.[2] This is of course due to the increased mechanisation of the various processes of manufacture, to the greater concentration

[1] See *Survey of the Textile Industries*. H.M.S.O., 1928.

[2] *Ibid.*, p. 271. The number has fluctuated around 260,000.

in large factories, and to the improvements in speed and efficiency of the machines. Of recent years there has been a marked tendency for steam power to be supplanted by electricity.[1]

Of the changes within the industry, the most notable is that wool has regained the position which it lost to worsted during the first half of last century. In 1921 there were 139,000 operatives in the woollen branch and 120,000 in worsted. Within the worsted branch, the spinning section has developed more than weaving, for an increasing amount of yarn has been needed by the hosiery trade and a considerable export has been maintained.

Finally, the last hundred years have witnessed important changes in the source of our raw wool supply, which we must now proceed to analyse. In the second quarter of last century about three-quarters of the wool used was home grown, the remainder being fine Saxon and Silesian varieties. Between 1830 and 1860, however, Australian and Cape wools began to displace all other imports, and with the expansion of the industry the home clip began to assume a less significant position, until at the present time that part of it which is retained in Britain represents only about one-fifth of the total quantity used.

Raw Materials

The raw materials of the woollen and worsted industries consist principally of the wool of the domestic sheep which is the most important of all fibres of animal origin used in the textile industries. There is no wild sheep with a fine fleece, and the sheep—now the most numerous of all domestic animals—was bred by man at an early date in the civilisation of the world. Even before the wool was used in weaving, sheep skins formed a valued protective covering. The fibres of wool differ from those of cotton in being covered with tiny overlapping scales, and the presence of these scales accounts for the "felting" properties of wool: the fibres can be beaten together into a fabric (felt) without weaving because the scales interlock. It is because the fibres of wool are usually finely curled or crimped that a woollen cloth includes a large proportion of air space. Air is a bad conductor of heat and thus woollen clothes, with their large amount of included air, are very warm.

[1] Power employed in woollen and worsted industries (Census of Production).

	1924	1930
Prime movers (*i.e.* steam engines and turbines)	445,000 H.P.	402,000 H.P.
Electric generators driven by prime movers	73,000 Kw.	91,000 Kw.
Electric motors and purchased current	152,000 H.P.	184,000 H.P.

Without attempting to account for their origin, it may be said that wool-bearing sheep at the present day fall into three main groups :—

(*a*) Original English breeds. In the Middle Ages wool was not only an important product but a leading export of England. The English breeds have become widespread in South Africa, Australia, and New Zealand. The animals thrive in cool, comparatively moist climates.

(*b*) Merino sheep. These sheep are natives of North Africa, but were introduced into Spain and other grassy areas in Mediterranean lands in the Middle Ages and later into Saxony. They yield but very poor meat and are bred essentially for their wool. They have become very important in South America, South Africa, Australia, and New Zealand. The animals thrive in dry climates.

(*c*) Cross-bred sheep. These sheep are derived from cross-breeding between merinos and English strains. A large proportion of the Australian and New Zealand flocks are cross-bred. Cross-bred sheep yield both meat and wool.[1]

Shearing by machinery is now usual at most large sheep stations, and as the quality of the wool varies considerably from one part of an animal to another, the fleeces are usually clipped round or "skirted," the inferior clippings being thrown into a separate bin. According to the age of the animal four grades of wool are distinguished :—

(*a*) Lamb's wool from 7 months old animals—the finest.
(*b*) Hoggets from 12 to 14 months old sheep.
(*c*) Wether wool from sheep of all other ages.
(*d*) Double fleece, representing two years' growth, is poorer in quality than a single-year fleece from the same animal and is cheaper.

Fleeces vary greatly in weight. Australian sheep average between 5½ and 7 lbs.; New Zealand sheep 7½ lbs. A prize fleece may be as much as 30 or 40 lbs.

Wool is graded according to the "count" or number of 560-yard hanks that weigh 1 lb.

(*a*) Fine counts, from 60 to 90 hanks to 1 lb. These are chiefly merino wools and are short stapled (2½ to 6 inches).

(*b*) Medium counts, from 36's to 60's. These wools are usually long stapled (up to 12 inches) and include the wools of English breeds and the cross-bred Colonial wools of South America and Australia.

[1] The introduction of refrigerator ships, by increasing the value of the sheep for meat, and thus concentrating attention of that aspect of sheep farming, led to a change in the character of Australian wool.

(c) Coarse or low counts, below 36's. These wools are more like hair, and include the wools of Southern Russia, Asia, and North Africa.

Wool as shorn from the sheep contains a large proportion of grease called " yolk " as well as varying proportions of dirt. It is usually exported " in the grease " and productions are queted on a " greasy " basis. The wool may be washed to remove dirt, but if the grease is removed the wool felts or mats together.

The wool is washed with water containing ammonia or some solvent to remove the grease—a process known as scouring. Greasy wool loses half its weight when scoured. The grease extracted is known as lanoline and is used in the preparation of toilet soaps. It should be noted that wool taken chemically from pelts is called " slipes."

The carding or combing processes result in the separation of " tops "—the long hairs, and " noils "—the short hairs, which are combed out.

In general it may be said that the woollen branch uses lower and medium grades of wool, " noils," mungo (torn rags and tailor's clippings) and shoddy (wool derived from soft woollen rags and knitwear), whilst the worsted branch uses merino and the finer grades of wool.

In addition, other animal fibres are used for certain purposes. Although including some of the finest of textile materials, the rarer animal fibres are usually handled by dealers specialising in " low wools " :—

Mohair is obtained from the Angora goat and is an important export from South Africa. There the goats flourish on the Karroo, where it is too dry for sheep. Mohair makes strong, lustrous materials, such as plushes.

Cashmere is the fine, downy winter undercoat of the Kashmir (or Cashmere) goat, a native of Kashmir, Tibet, and Southern China. Each fleece yields only about 3 oz.

Camel's hair is obtained mainly from China and Turkestan. The mane and hump produce strong hair, the remainder of the body downy " wool."

Alpaca, llama, vicuna, and *guanaco* are all animals native to South America, especially on the high Andes of Peru. The wool of the vicuna, a wild animal, is sometimes said to be the finest of all textile materials.

The table on page 457 shows the quantity of wool available for use in the industries in recent years. It should be remembered that the quantity *available* may not be a faithful index of the amount *consumed*, for wool is a non-perishable commodity that can withstand long warehousing.

Owing to the large sheep population of Britain, to the great amount of cross-breeding which has taken place, and to the fact that sheep named after a particular area are rarely confined to

RAW MATERIAL OF THE WOOL-TEXTILE INDUSTRY
(Million lbs.)

Variety	Average 1910–14	Average 1921–25	Average 1926–30	1931	1932	1933	1934	1935
Home clip [1]	95	52	72	86	87	60	73	65
Imported sheep and lambs' wool, mohair, alpaca, etc.[1] .	506	467	494	601	614	624	546	597
Wool from imported sheep-skins	35	22	24	27	24	24	20	16
Mungo and shoddy [2]	206	88	84	*	*	108	108	104
Total quantity of wool, mohair, and pulled wool available in United Kingdom	843	630	675	804	816	816	747	782

[1] Balance retained, after deducting exports (or re-exports).
[2] Estimated quantity.
* Not available.

that area, it is difficult to generalise about the home clip of wool. Our flocks may be roughly grouped into two classes, however, long-woolled and short-woolled. In the long-woolled class, the best breeds are the Lincoln, which yields a fleece of 9 to 10 lbs. in weight, and the Leicester; whilst other breeds are the Cotswold, the Romney Marsh, and the numerous varieties to be found in Devon and Cornwall, in many of the Midland counties, and in parts of Yorkshire. Most of the long-woolled sheep yield fairly coarse but lustrous wool which is almost invariably combed and spun by the worsted process. The short-woolled sheep fall into two groups, the mountain sheep yielding fleeces weighing about 3 or 4 lbs. and the breeds characteristic of the chalk areas yielding 4 or 5 lb. fleeces. The mountain sheep produce very variable fleeces, according to exact breed and region; the roughest wools are used in the carpet and tweed trades, the fine Cheviot wool for woollens, and the soft short wool of the Welsh and Irish mountain sheep is much in demand for flannels. The Southdown sheep produce the finest type of short wool which, until surpassed by Spanish, later Saxon, and now Australian merino, was the chief source of supply for the fine woollen trade. Now much of the Southdown wool is used either for flannels or is combed for hosiery yarn.

Between one-third and one-half of the home clip is exported—a testimony to its excellent quality—(see table on p. 470) and so extensive imports are necessary to make up the amount required in the wool-textile industries.

Gross Imports of Wool (Including Re-Exports)
(Million lbs.)

Variety	1913	Average 1921–25	Average 1926–30	1931	1932	1933	1934	1935
Sheep and lambs' wool: Merino	801	819	359	364	461	495	333	449
Sheep and lambs' wool: Crossbred			296	412	389	401	375	332
Sheep and lambs' wool: Other descriptions			146	73	68	91	80	83
Wool waste and wool noils	3	4	4	4	5	8	6	6
Mohair	28	22	14	11	9	18	8	11
Alpaca, vicuna, llama and camels' hair	13	10	9	8	5	7	6	7
Wool tops	*	4	3	2	1	1	1	1
Woollen, worsted, and hair yarn	33	15	18	19	1	1	1	2
Flocks and shoddy	122	*	51	49	24	32	*	*
Piece goods (million sq. yds.)	65	44	48	62	11	12	*	*

Imports of Wool and Mohair by Countries (Less Re-Exports)
(Million lbs.)

Country	1913	Average 1921–25	Average 1926–30	1931	1932	1933	1934	1935
New Zealand	143	146	117	119	125	124	121	109
Australia	126	123	166	218	220	233	197	278
Union of South Africa	81	60	61	69	106	81	50	65
Argentina	52	46	53	90	77	75	76	69
Other countries	104	92	98	105	84	111	117	94
Total	506	467	494	601	612	624	541	615

* Not available.

The second of these tables shows that the greater part of the import of raw wool is of Empire origin, Australia, New Zealand, and South Africa being the chief sources. Argentina also sends large quantities, and in the remainder the most notable items are Silesian merino, still imported, on account of its remarkable felting property, for the finest woollens; mohair from Turkey, and alpaca, etc., from Peru. The first table shows that in addition to raw wool a certain amount of shoddy is imported, and also " semi-finished " material in the shape of combed tops and spun yarns. The following table indicates the chief ports engaged in importing and exporting wool and woollen goods :—

PORTS EXPORTING WOOL AND WOOLLEN MANUFACTURES
(Millions of £'s sterling)

	1913	Average 1927–30	1931	1932	1933	1934	1935
Goole	2·9	4·9	2·7	2·7	2·9	3·1	3·5
Grimsby	5·8	3·3	1·4	1·2	1·0	0·9	0·9
Hull	5·7	11·5	4·4	4·9	5·9	7·0	8·5
Liverpool	11·7	21·1	8·0	7·6	8·6	10·1	10·2
London	6·6	10·2	5·2	5·3	5·7	6·2	7·0
Manchester	0·7	1·8	0·6	0·6	0·7	0·9	1·1
Southampton	1·2	3·0	1·6	1·3	1·8	2·0	2·1
Glasgow	0·5	1·6	0·6	0·6	0·7	0·8	0·9

PORTS IMPORTING RAW WOOL
(Million lbs.)

	1913	Average 1927–30	1931	1932	1933	1934	1935
Goole	6	10	8	5	9	6	9
Grimsby	15	8	6	3	5	2	4
Hull	48	136	123	134	138	95	174
Liverpool	182	143	185	178	216	200	221
London [1]	485	375	391	410	436	385	346
Manchester	0·2	14	25	17	13	9	6
Southampton	61	107	107	167	126	86	97

[1] The importance of London in this table is a result of the key position held by that city in the world's wool market. The Coleman Street wool sales are as vital to the woollen industry as the transactions of the Liverpool Cotton Exchange are to the cotton industry.

The Chief Branches of the Woollen and Worsted Trades

Only the briefest outline of the processes which lie between the raw wool and the finished cloth can be given here, and technical works should be consulted for further details.[1]

The wool is first sorted and classified into grades—long wools (destined for combing and the worsted trade), short wools (for carding, mainly for the woollen trade), and the lowest class for the carpet trade. In this connection it should be remembered that a single fleece is not homogeneous as regards its quality. Different parts of the animal yield wools of varying length and fineness. An allied preliminary process is the sorting of rags and tailors' clippings and their reduction to shreds in tearing machinery. The wool must next be scoured in a soap solution (for which soft water is essential) in order to remove the natural grease which it contains, and machinery must be employed finally to extract all burrs and other foreign bodies which may remain. The dry wool is oiled

[1] See, for example, A. F. Barker and others: *Textiles and their Manufacture.* Constable, 1922; or J. A. Hunter: *Wool, from Raw Material to Finished Product.* Pitman. 4th ed. 1930.

before passing through the next process in order to render it supple. The short wools are then passed through scribbling and carding machinery, the object of which is to mix up the fibres by taking advantage of their clinging properties and to produce a series of "rovings" or "slivers"—thin ropes of roughly parallel fibres—which are subsequently in the spinning process drawn out and given a twist which makes them into thread. During the carding operation any necessary admixtures (*i.e.* of rag wool, noils or cotton) may be accomplished. The woollen and worsted branches then follow rather different courses. For worsteds, the finer varieties of carded short wool and also the long wools which have not been carded are put through a combing machine which, by more careful means, so as not to cause damage by breakage and crushing, produces slivers of parallel fibres which are subsequently drawn out into finer and finer threads. The noils (short wools rejected during the combing process) go back into the woollen trade.

Then in both woollen and worsted, the finely drawn-out rovings are spun into a continuous thread. For certain purposes, especially to give strength to the yarn and produce a bi- or multi-coloured yarn, "doubling" of the thread is performed (*i.e.* twisting two or more threads into one). All yarns destined to form part of coloured cloths must, of course, have received their dye before being woven. The yarn itself may be dyed, but usually the uncarded wool or the combed tops are dyed before being spun.

Before weaving can commence, the warp and weft threads must be arranged in the required manner. Warping—or building up the warp—is a skilled process, still largely performed by hand; during or after the setting up of the warp, the yarn composing it is treated with size, in order to keep the threads smooth and prevent them from interlocking with one another. The modern high-speed loom is a triumph of automatism, which nothing short of a whole chapter or volume could adequately describe, and the variety of weaves and patterns which can now be mechanically produced is inexhaustible.

The finishing processes are many and varied. The cloth must first be examined for defects and mended where necessary. If woollen, it must be fulled, *i.e.* shrunk and felted—by being passed through rollers and through soap solutions; the nap must be raised by passing the cloth through drums set with teazle heads and then cropped by a kind of mowing machine. For worsteds, in which it is desired to show up rather than conceal the pattern of the weave, raising and cropping are unnecessary, but steaming and pressing contribute largely to the great variety of finishes which can be produced. If no colour has as yet been given to the wool the cloth may be dyed in the piece before the final finishing processes are completed.

Geographical Distribution of the Wool-Textile Industry

(*a*) *The West Riding.*—The dominance of the West Riding in all branches of the wool-textile industry has been a feature of industrial Britain for over a century. Whereas the worsted branch is almost extinct in those areas of East Anglia and the West Country where it once flourished, the woollen section has maintained a somewhat specialised existence in a number of different regions, notably East Lancashire, the Cotswold country and the Tweed Basin. In 1931, no less than 93 per cent. of the worsted workers in Great Britain were in the West Riding, but only 67 per cent. of the woollen operatives. The carpet industry has likewise persisted at several localities in Scotland and at Kidderminster, and less than 25 per cent. of the people engaged in the industry are in West Yorkshire.

Employment in Woollen and Worsted Industries, 1921 and 1931

	Woollen		Worsted	
	1921	1931	1921	1931
Great Britain	139,158	98,525	120,534	103,487
West Riding (and City of York)	94,578	65,406	112,376	95,550
Lancashire	8,457	6,511	320	575
Somerset, Wiltshire, and Gloucestershire	5,726	4,686	31	26
Leicestershire	486	504	1,132	2,006
Oxfordshire	1,134	1,233	19	15
Peebles, Roxburgh, and Selkirk	9,039	8,275	55	58

Employment in Carpet Industry, 1921 and 1931

	1921	1931
Great Britain	23,625	26,936
Worcestershire	6,945	8,902
West Riding	6,967	5,976
Glasgow	2,917	3,629

The two features of principal interest within the West Riding are the geographical distribution of the industries and specialities, and the relation between wool textiles and other occupations. Perhaps the outstanding elements in influencing the area covered by the textile-working district, in Yorkshire as in Lancashire, have been the supply of soft, or lime-free water from the Millstone Grit uplands and the outcrop of productive Coal Measures. The central Pennines, between the South Lancashire and West Yorkshire coalfields, are made up entirely of the Millstone Grit, for the most part peat-covered, and so giving an abundant surface run-off. The Grit consists mainly of hard sandstones, with alternations of coarser and more porous grits, which act as efficient filters and render the spring water extremely pure. It is noteworthy that the

textile industries extend farther south in Lancashire than in Yorkshire, by reason of the position of the watershed with relation to the Millstone Grit and Carboniferous Limestone formations (Fig. 210; cf. Fig. 67).

The West Riding industry is somewhat more localised, however, than the boundaries of the soft-water area would suggest (Fig. 211). Apart from one or two outlying centres on the headwaters of the Dearne and in the Wharfe valley, the industry is confined essentially to the coalfield portions of the Aire and the Colne-Calder valleys,

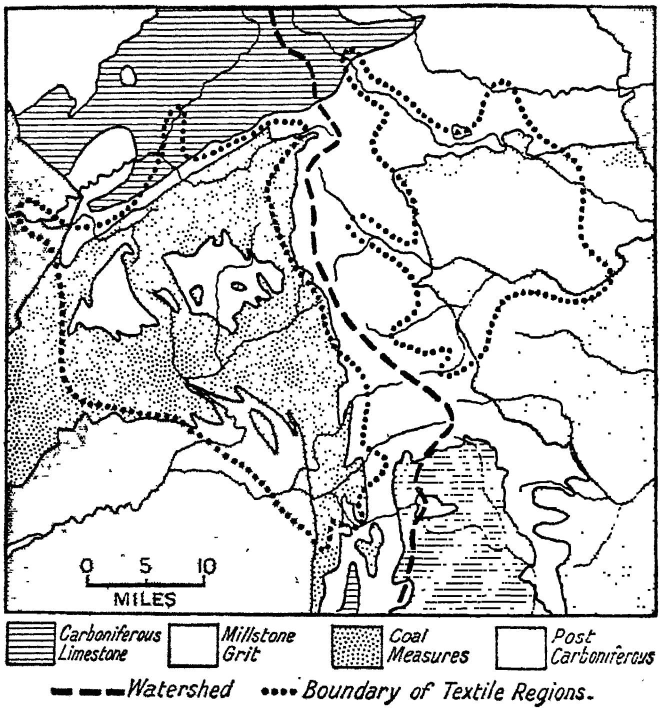

FIG. 210.—The Textile Regions of Lancashire and Yorkshire.
(For details of the Carboniferous Limestone area of the north-west, see Fig. 32.)

and the area which lies between them, together with the upper portions of those streams on the Grits. Eastwards of Leeds and Wakefield textiles cease to be of any consequence, and coal mining becomes the chief industrial occupation, but westwards of the main region tongues of industry spread up the Colne valley above Huddersfield, up that of the Calder above Halifax to Hebden Bridge and over into Lancashire, and up the Aire to Keighley and Skipton. The northern boundary of the main region is marked by the edge of the coalfield, roughly coincident with the river Aire

It should be noticed that the Aire, unlike the Colne and Calder, rises in a region of Carboniferous Limestone so that its water is not very soft. As a result, no great centres of the textile trade have grown up on it—the chief towns, Keighley, Bingley, Shipley, and Guiseley, being located on small tributary streams rising on the Grits or Coal Measures. The almost sudden cessation of the industry south of the Calder is also remarkable. It is due partly to the paucity

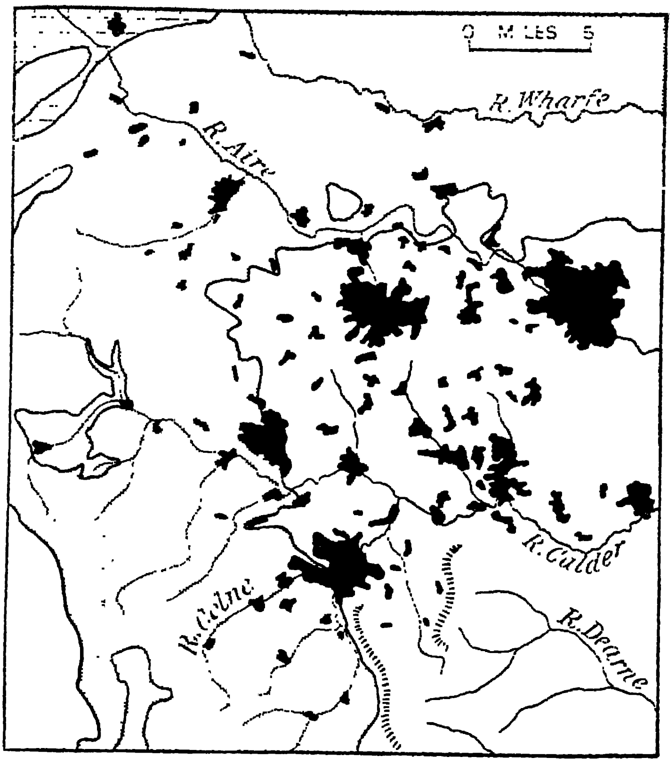

FIG. 211.—The woollen towns of Yorkshire in relation to the streams from the Millstone Grit.

The Millstone Grit is stippled, Coal Measures left blank. In the south-west are two areas enclosed by lines which are shown on some geological maps as "Carboniferous Limestone" but are actually of non-calcareous shales now classified with the Millstone Grit. The area in the north-west is of rocks of Carboniferous Limestone age, but is *not* limestone (compare Fig. 32). Notice in the south-east the scarps formed by Sandstones in the Lower and Middle Coal Measures (see page 43).

of water power in the region of the Dearne headwaters, which rise on the dipslope of the Coal Measure escarpments, but mainly to the long-standing economic differentiation of the Dearne-Don region, where Middle Coal Measure ironstone was formerly smelted and where textile trades (e.g. linen and coarse woollen cloths called

"pennistones") quite early became subordinate to the coal mining and metal trades of the Sheffield region.[1]

Within this comparatively restricted area there is a good deal of internal differentiation as regards the particular branches or phases of the wool-textile trades which are present. Both woollen and worsted manufactures are to be found all over the area, and there is no sharp regional division between them (Figs. 212–13). Worsted, however, is of relatively small importance in the south-eastern part of the area—Wakefield and the Dewsbury region—but is dominant in the north-western part—Bradford, Halifax, and Keighley. The

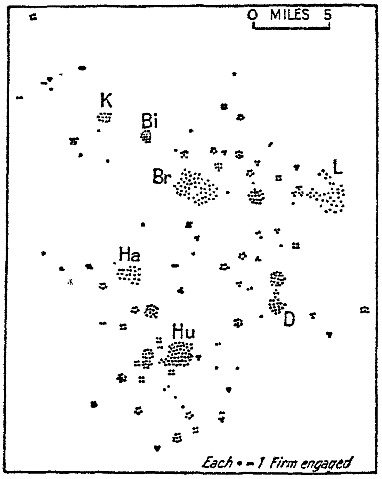

FIG. 212.—The *wool* industry of the West Riding.

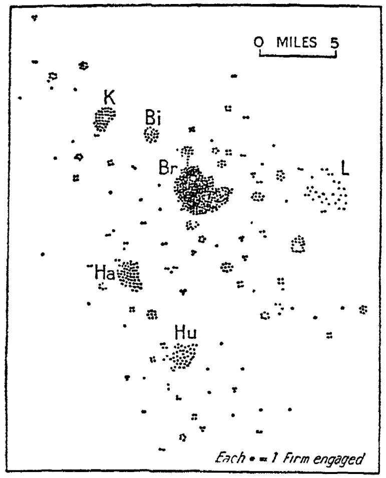

FIG. 213.—The *worsted* industry of the West Riding.

Notice the general predominance of wool in the south-east and of worsted in the north-west.
K = Keighley Bi = Bingley; Br = Bradford; L = Leeds; Ha = Halifax; Hu = Huddersfield; D = Dewsbury.

region within a radius of about six miles from Dewsbury, comprising the townships of Dewsbury, Batley, Morley, Ossett, Cleckheaton, and Heckmondwike, all north of the Calder, is the greatest in the world for the manufacture of mungo and shoddy and their employment in cloth-making.[2] In Dewsbury and Batley alone there are nearly 200 firms (some, however, very small) engaged in the sorting of rags which are subsequently torn up and re-spun and woven into cloth.

Regional specialisation in certain processes—a characteristic feature of the Lancashire cotton industry—is not much in evidence in the West Riding, owing to the peculiar organisation of the woollen branch, in which, as we have seen, a large proportion of the firms

[1] But see also E. Charlesworth, "A local example of the factors influencing industrial location." *Geog. Journ.*, XCI, 1938, 340–351.

[2] See S. Jubb: *History of the Shoddy Trade.* London, 1860, for the early development of this industry.

engage in all or many of the stages between raw wool and finished cloth. Without attempting to over-generalise, it may be said that in the western portion of the region (Halifax and the upper Calder, Bradford and the upper Aire) spinning and weaving are about equal in the numbers they employ in each centre; in the eastern and south-eastern parts, and especially in the small centres south of the Calder, weaving is rather more important than spinning. Dyeing shows a remarkable concentration upon Bradford, attracted thither by the dominance of merchanting and the finishing trades in the city, and is also developed in the middle portion of the Aire valley, between Leeds and Shipley, and in the Calder valley in and around Halifax.

Of individual towns which call for mention, Bradford holds pride of place as the metropolis of worsted and woollen manufacture. This city, apparently in the beginning destined, by reason of its situation on only a tiny stream, to be one of the *less* important centres, has risen since about the 'thirties of last century to a position of prominence unrivalled by its former peers, Leeds and Halifax. In 1800 it had one spinning mill and a population of 13,000. It is probable that the settling within its confines of a number of Jewish merchants, in association with German bankers, soon after 1830, began to increase its importance as a marketing and warehousing centre for worsted goods, and by a process of cumulative growth, and with the aid of the dyeing industry, which was considerably expanded about the same time, it rapidly rose to supremacy. At the present time its activities are concerned principally with combing, worsted spinning and weaving, and dyeing—but the woollen branch is by no means absent, and Bradford has almost a monopoly in the trades employing alpaca and mohair. Huddersfield concerns itself as much with woollens as with worsteds and is famed for its high-class cloth and its pattern designing. Halifax, until the rise of Bradford, was the chief worsted centre, and it still deals more in worsted than in wool. It is famed for carpets, although numerically the carpet trade only gives employment to six per cent. of the city's workers. Dewsbury, Batley, and the Spen valley towns, as we have seen, form the headquarters of the shoddy trade. Leeds is scarcely a textile manufacturing town at all. Only five per cent. of its workers are engaged in the woollen and worsted trades. It is a great textile-using city, however, and is the centre of the clothing trade which employs 17 per cent. of the working population (1931).

As regards the relative importance of wool textiles compared with other industries in the West Riding, some interesting unpublished maps made on the basis of the 1921 census by Dr. H. C. K. Henderson [1] show how, eastwards of a zone running southwards from Leeds *via* Ardsley and Ossett to the headstreams of the Dearne,

[1] Shown to the British Association (Section E) at York, 1932.

textiles become subsidiary to coal mining (Fig. 214, and cf. map of Yorkshire coalfield, p. 299). Few large mines remain within the textile region, which has thus to a certain extent lost one of the bases upon which its industry was built. The following figures show the number of people employed in the woollen and worsted industries

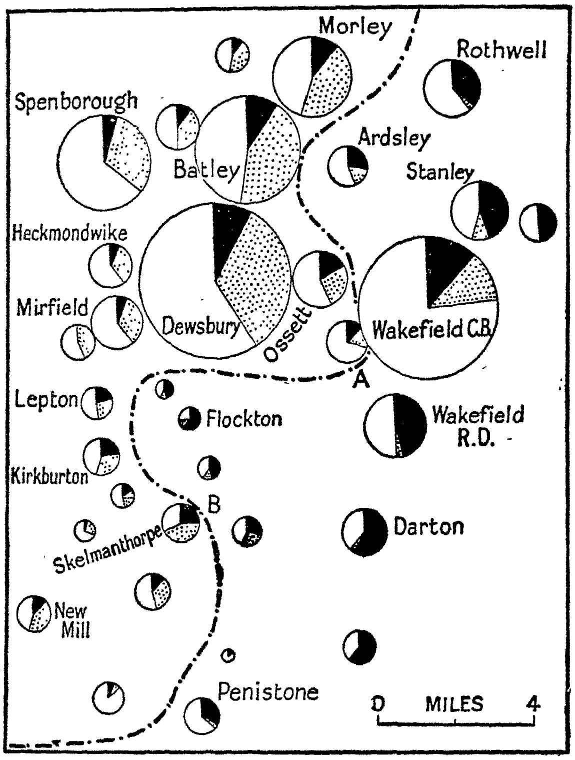

Fig. 214.

The transition between textiles and coal-mining occupations by census divisions: circles proportional to the number of people employed. Black = coal-mining; dotted = textiles; blank = all other occupations. West of the broken line, textiles more important than mining; east of the same mining more important than textiles. This line of division between A and B coincides with the Calder-Dearne water parting (compare Fig. 211). (Map prepared by H. C. K. Henderson.)

in the principal centres in 1924 and the percentage of the total employed population represented by this figure [1]:

		Per cent.			Per cent.
Bradford	63,490	52	Shipley	9,382	64
Huddersfield	24,139	45	Leeds and Armley	8,960	6
Halifax	11,944	30	Morley	7,715	52
Dewsbury	11,607	57	Keighley	7,622	40
Stanningley	9,697	66	Wakefield	5,380	16
Batley	9,669	63	Spen valley	4,916	28

[1] Ministry of Labour returns—from Shimmin: *Jour. Roy. Stat. Soc.*, 1926.

It is noticeable that the Dewsbury group shows greatest concentration of activity upon wool textiles (the only other occupation of importance here being coal mining). Some of the large towns, however, are seen to be far less devoted to wool than might have been expected. Leeds, the most diversified city in the whole conurbation, has several trades which exceed textiles in importance—tailoring, engineering, distributive trades, and the building industry. Bradford, of course, has a considerable dyeing industry, and like all great cities, employs many thousands of people in the distributing trades. Huddersfield and Halifax both have prominent engineering industries; Halifax has carpets, and both have a cotton trade employing over a thousand people. Wakefield is more important as a coal-mining centre, and has engineering works, as well as being the administrative centre of the county of West Riding; whilst Keighley (cf. Fig. 202) is also a great engineering town. The Spen valley towns also have considerable engineering industries, as well as carpet making. In the western extremity of the region we find that in Sowerby Bridge and Hebden Bridge, cotton rivals wool in the number of workers which it employs.

(*b*) *East Lancashire.*—The ancient woollen industry of South Lancashire has become very restricted and specialised since the growth of cotton manufacturing. As stated above (p. 449) it has been pushed eastwards up the Pennine valleys, where there are now two areas concerned, one north of Manchester, in the valley of the Roch where Rochdale and Bury are the chief centres, and the other east of Manchester, in the Tame valley about Mossley and Stalybridge. The woollen branch predominates, and the specialities are felts (upon which an extensive slipper industry depends), flannels, and blankets.

(*c*) *West of England.*—The decline and increasing specialisation of this region have already been considered (p. 453). The spinning of yarn has practically ceased and the weaving and finishing of special types of cloth is all that remains. Stroud is still the principal centre of the trade in highly finished cloths of the broadcloth type for liveries, uniforms, hunting outfits, and billiard tables. Outlying centres continue to flourish in a small way, such as Dursley, making woollens and carpets, Witney,[1] the blanket town, Trowbridge, woollens and some worsted, Frome, Wellington, and one or two minor survivals of the Devonshire serge trade, as at Ashburton. At Kidderminster the carpet industry continues to flourish after two centuries, and nearly 9,000 people are employed here and at Stourport.

(*d*) *Wales.*—Many parts of Wales formerly had a considerable domestic woollen industry, using locally produced wool. Much of this industry has been mechanised and factories, most of them small,

[1] One firm at Witney claims to have been making blankets since 1670. See A. Plummer: *The Witney Blanket Industry.* Routledge, 1934.

are to be found scattered in a great many towns and villages in central and west Wales. The greatest concentration is in Carmarthenshire in the valley of the Teifi between Lampeter and Newcastle Emlyn. Flannel is the principal product.

(*e*) *Leicestershire.*—The growth of the woollen and worsted industries is a natural outcome of the expansion of the hosiery trade. As a result, they are of rather a specialised nature, being concerned primarily with the production of worsted and some woollen yarn destined for subsequent manufacture, within the same region, into hosiery proper and all allied types of "knitwear"—underwear, pullovers, bathing costumes, etc. The principal seat of the industry is Leicester, but a number of neighbouring towns share it to a certain extent, as Melton Mowbray, Wigston, and Loughborough (cf. Chapter XXII).

(*f*) *The Scottish Border.*—A well established domestic linen and woollen industry existed in the Tweed basin prior to the Industrial Revolution, based upon local flax-growing and wool from the Cheviot and black-faced mountain sheep, and aided by copious supplies of soft water from the limestone-free Silurian and Old Red Sandstone formations. The decline of the linen trade due to competition from better situated areas in Fifeshire and Ireland, and the introduction of machinery into woollen manufacture, brought about a changed distribution. Attention became focused upon water-power sites on the change of gradient between the narrow tributary valleys and the broader central basin of the Tweed—and towns situated in such places as, for example, Galashiels and Hawick, expanded considerably as a result. Subsequent development was hampered, however, by the absence of coal, the somewhat isolated nature of the region as regards populous markets, and the attendant lack of facilities for easy import of foreign wool. Competition with Yorkshire being out of the question, specialisation has occurred and the region has become world-famous for "tweeds"[1] of high quality, and for hosiery of all kinds, the latter being the speciality of Hawick. In consequence much foreign wool is now imported, and the industry survives to-day by reason of a foundation laid during a period when local geographical conditions were more favourable. The topographical conditions for mill and town development, owing to the narrowness of the valleys, are not very favourable, and in the 'seventies of last century the Galashiels industry had to find a new outlet at Selkirk, with the result that the population of the county named after that town increased by 80 per cent. between 1871 and 1881.

The post-war depression with its accompanying lack of real

[1] The name was originally "twill" or "tweel," which an English clerk's error transformed into tweed—and this mis-spelling happening to be the name of the river basin, it has stuck to the cloth and the trade.

demand for the costly high-quality products, hit the industry badly. A partial relief has been obtained by the introduction, as at Jedburgh, of the artificial silk trade; but the present adverse geographical factors are outweighing even the momentum of several centuries.

(*g*) *The Rest of Scotland.*—Just as in Wales, the natural aptitude of many parts of Scotland for sheep rearing gave rise to a widespread

[*Photo : A. C. O'Dell.*

FIG. 215.—A crofter's wife spinning in the Shetland Islands, 1931.

domestic woollen industry, of which, despite the progress of mechanisation and the development of factories, many scattered remnants still remain. Small mills for spinning and weaving tweed cloths, blankets, and carpets are to be found in nearly every county, and only one or two of the more important regions can here be mentioned. Although completely overshadowed by more modern industries, the old woollen trade survives in Ayrshire, as at Kilmarnock and Ayr, and in the Glasgow-Paisley district, where carpets are made and where the industry is partly an associate of the cotton

EXPORTS OF WOOL AND WOOLLEN GOODS BY VARIETY

(In 100 Centals = 10,000 lbs.)

Variety	1913	Average 1921–25	Average 1926–30	1931	1932	1933	1934	1935
Wool (British only)	2,866	5,209	4,118	3,577	4,191	6,944	5,540	*
Noils and waste	3,388	3,449	3,166	2,011	2,429	3,236	2,718	3,580
Tops	4,363	3,736	3,431	2,799	4,175	4,583	4,175	5,593
Yarn, *worsted*	4,990	3,712	3,786	2,978	3,203	3,582	3,413	3,308
Yarn, woollen	481	784	654	515	600	759	877	781
Tissues, worsted (million sq. yds.)	62	54	41	30	28	33	33	38
Tissues, woollen (million sq. yds.)	106	129	113	56	54	61	69	71
Yarn, alpaca, and mohair	1,722	738	761	406	336	447	403	438
Other yarns of hair and wool	848	307	712	640	612	594	*	*
Flocks, shoddy, and rags	2,326	2,501	3,106	2,269	1,744	3,562	4,431	*
Piece goods (million sq. yds.)	187	185	169	95	91	105	115	*
Carpets (million sq. yds.)	11	7	7	3	4	3	5	6
Blankets (1,000 pairs)	1,002	1,235	990	409	362	368	496	417
Flannels (million sq. yds.)	—	6	4	3	3	4	5	5

* Not available.

EXPORTS OF WOOL AND WOOLLEN GOODS BY COUNTRIES
(Millions of £'s)

Country	1913	Average 1921–25	Average 1926–30	1931	1932	1933	1934	1935
Germany	9·5	7·0	8·7	4·0	4·4	4·6	4·2	2·4
Canada	4·4	6·2	6·6	2·6	2·3	2·7	3·3	3·4
Australia	2·4	5·3	3·1	0·3	0·7	0·7	1·0	1·1
New Zealand	0·5	1·2	1·3	0·6	0·7	0·7	0·8	0·8
South Africa	1·5	1·5	1·6	1·2	1·0	1·4	1·6	1·9
China	0·6	3·7	3·2	1·8	1·1	0·9	1·2	0·6
Japan	1·9	7·3	2·8	1·2	1·0	0·7	0·4	0·7
India	1·3	1·0	1·3	0·4	0·7	0·7	0·8	0·7
Other Countries	11·9	27·4	22·4	13·1	12·1	13·2	15·5	18·8
Total	34·0	60·6	51·0	25·2	24·0	25·6	28·8	30·4

The Trade in Wool and Worsted since 1918

The export trade in woollen and worsted goods had been gradually declining for forty years before the 1914–18 war, owing largely to the establishment of wool-using industries in foreign countries. The worsted trade declined the most, since the more standardised worsted fabrics are easier to produce than variegated woollen goods; the export of tops, however, correspondingly increased to supply these new foreign industries. After a post-War boom which lasted until about 1924, a gradual decline ensued. Three main causes contributed to this: first the failure to maintain the Far Eastern markets which were won (almost in fact, created) during the early 'twenties; second, the fall in raw wool prices, which materially aided the production of cheap Continental fabrics; third, the decline in the consumption of all wool goods—a natural result of the increasing preference for artificial silk and mixed fabrics, especially for knitted goods. The fall in wool prices also did much damage to the shoddy trade, by enabling more new wool to be consumed. The general result was a decrease in employment (see table on p. 442). The best prospects for the future lie, perhaps, in the mass production of fabrics for ready-made clothing—an industry which has expanded rapidly in recent years, and in a specialisation on the part of the worsted trade in yarn for hosiery and knitwear.

industry. Between the Forth and the Tay, on the steep southern slope of the Ochil Hills, where there was abundant water power, a tweed industry still remains centred on Alloa and Tillicoultry ; and numerous small mills are to be found in the valleys running south-eastwards and north-eastwards from the Grampian massif. Finally, mention must be made of the hand-loom production, in the Hebrides, of the famous "Harris homespun" tweeds ; and of the domestic hosiery industry of the Shetlands. Much of these trades is, perhaps unfortunately, now being commercialised and machine-spun yarn is being used in order to speed up production. The chief spinning centre in the Highlands is Brora, on the small coalfield.

(*h*) *Ireland.*—Here, as before, we find a scattered domestic woollen industry which has become partly industrialised. A number of small towns in Northern Ireland, and some in Eire, notably in the hinterland of Cork, have mills where woollen cloths, tweeds and blankets are produced, but Ballymena, Belfast, and Cork are the only towns where more than one firm is engaged.

WOOLLEN AND WORSTED INDUSTRIES: PRODUCTION
(Million lbs.)

Variety of Product	1907 (United Kingdom)	1924 (Great Britain)	1930 (Great Britain)
Tops	243	286	244
Noils	30	35	28
Yarns	446	550	372
Woollen	260	314	191
Worsted	—	211	158
Alpaca and mohair	186	15	8
Other hair or wool	—	10	15

(Million yards)

Variety of Product	Linear	Square	Square
Wool and worsted tissues	246	419	304
Damasks, plushes, etc.	7	10	5
Flannels and delaines	51	25	16
Blankets (thousands of pairs)	3,103	3,017	3,074

Note.—Ireland produces a small amount of wool and worsted yarns only.

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CHAPTER XXI

THE TEXTILE INDUSTRIES: COTTON[1]

THE cotton industry, unlike that of wool, has no long history stretching back into the Middle Ages: its expansion is roughly coincident with the period of the Industrial Revolution. Moreover, it has always been entirely dependent upon imported raw material, and it is to-day very largely dependent upon foreign outlets for its produce. The study of its development and localisation is thus intimately bound up with considerations of sources of power and of inland and ocean transport facilities. But this is not all. Of the 440,000 people employed in the industry in 1931, no less than 84 per cent. were enumerated in Lancashire and the adjacent parts of Cheshire and Derbyshire. Such a remarkable concentration cannot be due to power supplies and port facilities alone, for several other regions of Britain possess equally good advantages in this respect. It will, therefore, be our business in this chapter to attempt an analysis (*a*) of the factors which contributed to the original localisation of the cotton industry in Lancashire and elsewhere, and (*b*) of the physical and economic circumstances which have enabled the Lancashire region to adapt itself to new discoveries and new requirements, and so to develop the remarkable concentration and specialisation which characterise it at the present time.

Historical Geography of the Cotton Industry[2]

(*a*) 1600–1770.—It is probable that, from the thirteenth century onwards, small quantities of cotton wool were imported into England for the making of candle wicks, and in the sixteenth century this trade was fairly regular. Definite evidence of the spinning and weaving of cotton in this country is lacking, however, until about 1600. Cotton had been utilised on the Continent for a considerable period (in Spain, Italy, Germany, and Belgium, for

[1] By S. H. Beaver. The authors are greatly indebted to Mr. J. A. Todd, Principal of the Liverpool School of Commerce, for his valued criticism of this chapter. Mr. H. L. Beales kindly read through the historical sections.

[2] Of the abundant literature on the history of the cotton industry, the following books are "classics": E. Baines, *History of the Cotton Manufacture*, 1835. S. J. Chapman, *The Lancashire Cotton Industry*, 1904. G. W. Daniels, *The Early English Cotton Industry*, 1920. Wadsworth and Mann, *The Cotton Trade and Industrial Lancashire*, 1600–1780, 1931. A more popular account will be found in Wood and Wilmore, *The Romance of the Cotton Industry in England*, 1927

example) and it is probable that Flemish refugees introduced it into Britain. At Norwich, the home of fine fabrics (cf. p. 447), fustians and bombazines (mixtures of linen and cotton, or silk and cotton) were being made, possibly before 1600 and certainly in 1605, and in South Lancashire, where many foreigners settled, fustians began to be produced about the same time, using cotton imported from Smyrna, the Levant and Cyprus, and linen from Scotland and Ireland. In East Anglia the manufacture was clearly an ally of the worsted industry which we have already discussed (Chapter XX). In South Lancashire it attached itself quite naturally to an existing linen and woollen industry. Manchester was making woollen cloth in the early fourteenth century, and in the sixteenth century the linen trade of Manchester, and the "Manchester cottons" (made of wool) produced at that town and at Bolton, are commented upon by Leland. The use of cotton was slow in developing, however, and as yet the fibre was only used for mixing with others, for it could not be spun into a thread strong enough for employment as warp. By the end of the seventeenth century, aided by the great damage done to the Continental industry by the Thirty Years' War, and by the increasing demand for fustians, the industry was definitely established and concentrated chiefly in the Manchester region.

Manchester, like Birmingham (cf. Chapter XIX, p. 419), was a non-corporate town—"neither walled town, city, or corporation" (Defoe)—free from the strict regulations of the larger populous centres and thus able to accommodate foreigners and new industries without trouble. It lay, too, outside the area dominated by the trading activities of the Merchant Adventurers, and so could develop unhampered by restrictions. Three branches of the textile industry grew up—the woollen "cottons" referred to above, checks and small-ware (tapes, etc., often made of worsted) and fustians (made from linen warp and cotton weft). At the same time, whilst Manchester was the centre of the new industries, Bolton also made fustians, Rochdale and East Lancashire generally still retained a flourishing woollen trade, and Warrington, developing as a port, was famed for its sail cloths. The prohibition (at the instigation of the silk and woollen manufacturers) of the import of printed and dyed calicoes (obtained from India), in 1700, resulted in the setting up of a printing and dyeing industry in London (where the "grey" cloths were imported) and in Lancashire; and when in 1721 the *use* of printed calicoes was forbidden, Lancashire took up fustian-printing, an industry which was legalised by the famous "Manchester Act" of 1736.

The steady, if slow, expansion of the cotton-using industries in Lancashire during the first half of the eighteenth century [1] was

[1] In 1701, just under 2,000,000 lbs. of raw cotton were imported; in 1751 nearly 3,000,000 lbs.

accompanied by the rise of Liverpool as a port. With the gradual silting up of the Dee estuary, Chester was declining,[1] and the improvement of Warrington in the 1690's, followed by the construction of the first docks at Liverpool in 1715, and the improvement of the Mersey-Irwell navigation to Manchester, commenced in 1720, are evidence of the need for oceanic inlets and outlets for the growing trade of South Lancashire. Liverpool was not really important as an importer of raw cotton, however, until the main source of supply shifted from the East to the West (*i.e.* the United States). The one great handicap of the Manchester region (cf. Birmingham) was the lack of good roads. The pack-horse provided the only available means of overland transport and most of the raw

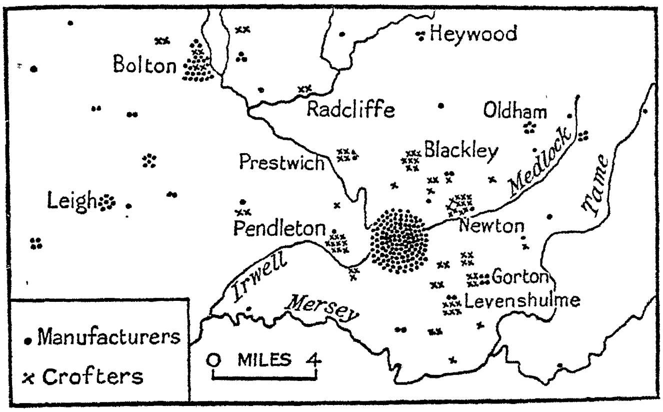

FIG. 216.—The distribution of cotton users in South Lancashire at the end of the pre-machinery period.

cotton was obtained from London by this method. Another feature which prevented much expansion until after the invention of machinery was the scattered and rather widespread nature of the domestic spinning and weaving industries, which at this time were largely part-time occupations of families also engaged in farming. Although from quite early times the merchants (the equivalent of the Yorkshire "clothiers") employed large numbers of people, large-scale output of homogeneous fabrics was obviously impossible before the coming of the factory age.

Fig. 216 shows the distribution of the cotton-using industries in South Lancashire at the end of the pre-machinery period.[2] The concentration on the Manchester district is remarkable, and may be regarded as an expression of the dominance of that town over the

[1] See H. W. Ogden, "Geographical Basis of the Lancashire Cotton Industry," *Journ. Textile Inst.*, XVIII, Nov., 1927, pp. T573–594 (useful maps).
[2] Data from Daniels, *op. cit.*, pp. 69–70.

Lancashire region. Defoe had described it as "the greatest mere village in England," with a population, in its parish, of some 50,000; and whilst there was as yet no incentive to move into the comparatively barren hill country in search of water power, the lowland agricultural area around the Medlock and middle Irwell basins proved the more attractive region. Of the "manufacturers" shown in Fig. 216, the makers of small-ware were all in Manchester; the check-weavers mostly in Manchester and an "inner circle," comprising what are now the city's suburbs (*e.g.* Failsworth, Gorton, Levenshulme) and the fustian makers in Manchester, and in an outer circle (*e.g.* Leigh, Bolton, Oldham). The crofters or "whitsters" who performed the bleaching operations [1] were grouped in the villages around Manchester (Blackley, Newton, Pendleton) and in the Irwell valley (*e.g.* Prestwich, Radcliffe, Bolton)—a location which, as we shall see, has been preserved even to the present time, though the methods and requirements have changed considerably.

(*b*) *The Industrial Revolution.*—The factors which contributed to the localisation of the cotton industry in South Lancashire in the seventeenth century—the existence of linen and woollen industries in the soft-water region of the Pennine flanks, and the settling of foreigners in a non-corporate town, are not sufficiently exclusive or conclusive to explain the present concentration. Numerous other regions had soft water, Flemish weavers, and an atmosphere humid enough for successful spinning. The secret of the expansion of the industry in Lancashire lies in the fact that as each new development arose, so the natural environment of the region was found capable of being utilised in the desired manner. When machinery was invented, water power was available; when steam power arrived coal could not have been in closer proximity; the development of chemical bleaching was aided by the presence of the Cheshire salt field, only a few miles away, and by the abundance of soft water; and the need for transport could be satisfied by comparatively easy canal and railway construction, and by the enlargement of the existing ports of Liverpool and Manchester. The Industrial Revolution period witnessed all these factors in operation.

Prior to the invention of machinery the textile industries were essentially home occupations. The home-made spinning wheel and hand loom were the only essential requirements. The difficulty which weavers experienced in getting adequate supplies of yarn [2]

[1] The method employed was to steep the cloth in sour milk, spread it out on grassy slopes, and allow the sunlight to do the bleaching. It was a process occupying several months.

[2] "It was no uncommon thing for a weaver to walk three or four miles in the morning and call on five or six spinners before he could collect enough weft to serve him for the remainder of the day." (Guest: *Compendious History of the Cotton Manufacture*, p. 12.) The situation was aggravated in the summer months by the spinners neglecting their spindles for more urgent agricultural labour.

was only aggravated by Kay's flying shuttle (patented in 1733, but not much used until the 60's), and in consequence the early inventions were all designed to facilitate the spinning process. Hargreaves' "jenny" (named after his daughter) merely multiplied the number of spindles which could be handled by one operative,[1] and still could not produce a yarn strong enough for warp. Arkwright's invention [2] of roller spinning, however, making use of rollers moving at different speeds for drawing out the rovings into yarn, remedied this deficiency. His machine, although patented at first to be worked by a horse, was quickly adapted for driving by water power, and hence came to be known as the "water frame." It may be said to have wrought two great changes in the cotton industry. In the first place, it made possible the weaving of all-cotton cloth (calico)—a manufacture which, owing to the existing prohibitions (*vide supra*), had to be legalised in 1774—and thus, by rendering unnecessary the admixture of linen and wool, contributed to the decline of those industries in Lancashire; [3] secondly, it caused the first vital change in the localisation, within Lancashire, of the production of yarn, by making water power an essential. But progress in the use of water power was at first slow. There was a natural reluctance on the part of the people to work in factories; then the lapse of Hargreaves' patent allowed the rapid spread of the jenny, which needed no power, and Arkwright, driven from Lancashire by hostility to his machines,[4] set up his works in Nottingham, the home of flourishing hosiery, lace, and silk industries, and later at certain power sites in the hosiery-making district of Derbyshire (Cromford 1771, Derby 1773, Belper 1776). Another factor contributing to the expansion of the industry was Crompton's mule, constructed in 1779, and so called because it combined the principles of the jenny and the roller. This machine spun thread for both warp and weft, and was capable of producing counts of much greater fineness than ever heretofore. As it was never patented, its use quickly spread, and in the 'eighties it began to supersede the jenny. It was not adapted for water power until 1790, after which, during the last decade of the century it was adopted for producing the finer types of yarn, Arkwright's water frame spinning the coarser counts.

[1] The first jenny, in 1770, had 16 spindles. Twenty years later machines were being constructed with over 100.

[2] Like so many "inventions," the principle of roller spinning was not the product of the brain of the man whose name is associated with it. It is due to Lewis Paul, whose first machine was made in 1738—30 years before Arkwright's patent.

[3] By 1790 woollen manufacture had disappeared, except in a specialised form in East Lancashire, and the linen industry was almost dead.

[4] Arkwright did not at first intend to make calico, but as the Lancashire weavers refused to buy his machine-made yarn he had to use it himself in the manufacture of all-cotton cloth.

The early machinery age thus falls naturally into two periods. The first, from 1770–90, is characterised by the endeavour to provide an adequate supply of yarn, by the birth of the new cotton industry, by the inauguration of the factory system, consequent upon the use of water-driven machinery, and by an important migration of the industry away from Manchester and into the steeply-graded valleys of the western Pennines and the Rossendale upland, where water-power was available. The second, from 1790 until 1800, is a period of development and consolidation, in which two pieces of machinery played important parts. The mule enabled the trade in fine fabrics, for so long an Indian monopoly, to be captured by Lancashire and by the Glasgow-Paisley district of Scotland, where the cotton industry began to supersede that of linen (*vide infra*). The steam engine, which Watt began to develop for driving machinery about 1785,[1] not only enabled far greater power to be obtained, but also confirmed the existing localisation of the industry on the Lancashire and Lanarkshire coalfields. The increasing use of machinery gave rise to a new industry—the building of machines for the mills which were springing up in many of the coal-field valleys. The import of cotton rose by leaps and bounds, a new and prolific source of supply appearing in the United States.[2]

All this time, however, weaving had lagged seriously behind spinning in technical developments, with the result that the hand-loom weavers, supplied now with a surfeit of machine-spun yarn, were enjoying a period of great prosperity. It is true that Cartwright had invented a power loom in 1785, but although several were erected none was successful until, about 1804, Radcliffe overcame the liability of the cotton yarn to break when subjected to mechanical handling by steeping the warp in boiling size before mounting it in the loom. Thus it was not until about 1806 that the power loom, later improved by Horrocks, became a commercial proposition—to the serious detriment of the hand-loom weavers.

Two trends are to be discerned in the localisation of the weaving industry. At first, there was a temporary migration of many of the cottage looms into weaving sheds attached to the new beck-side spinning mills. Then, with the introduction of the power loom, a process of disruption began, due to a number of causes. The hand-loom weavers were a body of skilled workers who objected to working in " factories " and who saw in the coming of machinery the grim spectre of unemployment and ruin. Unlike the early spinning machines, the power looms did not need skilled operatives

[1] The first engine for a cotton mill was erected at Papplewick, Notts, in 1785; Manchester obtained its first in 1789, and Glasgow in 1792. By 1800 Manchester had 32 steam engines.

[2] Import of raw cotton in 1781—5,000,000 lbs.; 1800—56,000,000 lbs. See also p. 490.

and could be worked or attended by women and children—at, of course, low wage rates. It is little wonder then that many of the early machines and factories were damaged or destroyed in a series of riots during the second and third decades of the nineteenth century.[1] Many weaving masters, potential factory builders, migrated to the northern slopes of the Rossendale upland, where the cotton industry was less highly developed and where the hatred of machinery was less intense. To this migration, and to the increasing separation of spinning and weaving, due to the large number of new fabrics and the impossibility of weaving firms spinning all the varieties of yarn which they required, the beginnings of the modern specialisation in the industry, dating from about 1840, are due.[2] The use of the power loom did not take the industry by storm, however, as the spinning machines had done,[3] and for a long period, just as in the woollen industries, the hand loom continued to be an important factor in the cotton manufacture. Even in the 1830's, when the cotton industry in Great Britain possessed about 100,000 power looms, perhaps 250,000 hand-loom weavers remained.[4] Some remained—in Glasgow for example—even after 1880.

It must not be assumed that spinning and weaving were the only two processes in the cotton industry to be mechanically performed. As far back as 1748 Lewis Paul had patented a carding engine, and Arkwright placed a whole series of carding and drawing machines on the market in the late 'seventies. Many other machines were designed to perform the many processes through which the raw cotton goes before it is ready for spinning.

Another very important series of inventions concerned the bleaching and dyeing of yarn and cloth and the printing of calico. The year 1785 witnessed great advances in the methods of both bleaching and printing. Berthollet, a French chemist, discovered the bleaching properties of chlorine and his ideas quickly became known in Lancashire, the centre of the English calico industry. The new process, as improved by Henry and others in Lancashire, reduced the time necessary from many months to a few days. Its essential requirements were chlorine, easily obtained by canal from the salt deposits of Cheshire; lime, sent by canal from the

[1] We must not assume that the Luddite and other riots were due *entirely* to the fear of machinery. The general resentment of wage levels and food prices during the great post-war depression should also be taken into consideration. (Daniels, *op. cit.*, pp. 83–91.)

[2] See J. Jewkes, "The Localisation of the Cotton Industry," *Economic History*, II, Jan. 1930, pp. 91–106.

[3] Domestic spinning was almost extinct in the towns by 1785, although it lingered in the country districts for several decades. In 1813 there were about 100 power looms in the Manchester district, and about 2,400 hand looms.

[4] This figure, given by Baines (*op. cit.*, p. 396) is generally regarded as being too high.

in number. (1) An absolute expansion of the output, accompanied, however, by a decline relative to the world's total (cf. iron and steel, and shipbuilding). The only serious set-backs received until the Great War were the result (*a*) of the cotton famine brought about by the American Civil War; (*b*) of the great depression of 1873–96, during which the general economic depression, the depreciation of silver (affecting the purchasing power of Eastern countries), and the commencement of foreign competition combined to arrest the triumphant progress of the first half of the century. (2) An increased separation of the spinning and weaving branches, with the development of a "horizontal" system of organisation. (3) An increased specialisation in the finer types of yarn and fabric, and in fabrics for special markets—a consequence of foreign competition in the production of cheap goods and of the comparatively high cost of raw material as a result of distance from its source. (4) Changes in the mode of transport, the railway superseding the canal, and the road now seriously competing with the railway for the carrying of raw cotton and finished goods. (5) The growth of associated industries, notably textile-engineering and the manufacture of chemicals. (6) The beginning, in recent years, of a change in the source of power, increasing use being made of electricity.[1] There is one feature which distinguishes the cotton from the woollen industry during the Industrial Revolution period, however, and that is the earlier mechanisation of cotton manufacture. Cotton was a well established factory industry in the 'thirties when the greater part of the wool-textile industry, with the exception of worsted spinning, was still in the domestic stage.[2]

Before considering these trends in detail we must pause and

[1] Power employed in cotton industry 1924 and 1930 (Censuses of Production). (*Cf.* footnote on p. 454, Chapter XX).

	1924	1930
Prime movers (steam engines and turbines)	328,000 H.P.	283,000 H.P.
Electric generators driven by prime movers	20,000 Kw.	28,000 Kw.
Electric motors and purchased current . .	52,000 H.P.	75,000 H.P.

[2] Persons employed in textile factories (*British Commerce and Industry*, Ed. by J. W. Page, vol. II, p. 230).

	Cotton	Wool
1835	219,286	55,461
1850	330,924	154,180
1861	451,569	173,046
1870	450,087	238,503
1880	528,795	301,556

examine the geographical background of the cotton industry in Lancashire and in Scotland.

The Geographical Background of the Cotton Industry

(*a*) *Lancashire.*—In analysing the factors which have contributed to the remarkable concentration of the cotton industry in Lancashire we must attempt to differentiate between true localising factors, *i.e.* factors which were responsible for the placing of the industry just where it is, and factors which have merely been assets in confirming that localisation and in hindering any serious migrations into other regions. In the first category we have the historico-geographical influences already dealt with—the physical environment which aided the rise of woollen and linen industries on the western flanks of the Pennines (cf. Chapter XX), and the part played by Manchester, as a non-corporate town, in attracting industry to itself. In the first class, too, are the water power provided by the numerous steeply-graded streams and the soft lime-free character of the water of those same streams. The combination of lime-free water and water power has been the most powerful factor in determining the location of the individual producing centres and the boundaries of the cotton-working region. Of the second class, first and foremost is the existence of productive coal measures. Lancashire could scarcely have attained to its present position had it not been for the coalfield; the industry would probably have died a natural death before the middle of last century. Other important auxiliary factors are the naturally high humidity of Lancashire, which reduced the necessity for expenditure upon humidifying apparatus for spinning mills; the proximity of the Cheshire saltfield, providing essential materials for the bleaching industry; and the facilities for rail, water, and road communication offered by the natural routeways of the Pennine and Rossendale streams, and by the flat plain of south-west Lancashire between Manchester and Liverpool.

The physical setting of the industry has already been alluded to; let us now examine it in rather more detail. The core of South Lancashire is the Rossendale anticline, trending in a WSW direction from the monoclinal axis of the Pennines. On the north side of the upland are the towns situated in the valleys of the Darwen and Calder, tributaries of the Ribble; south of the upland are the towns in the middle Irwell and Roch valleys; and in the denuded heart of the upfold lie the towns strung along Rossendale, the upper valley of the Irwell. The fourth group of cotton-working centres lies in the valleys of the Medlock, Tame, and upper Mersey, which flow down from the Pennines (Fig. 217). The Pennine region and much of the Rossendale upland are made up of the thick Millstone Grit Series, and the flanks of the latter are composed mainly

of Lower Coal Measures. These systems are characterised by similar lithology, consisting mainly of hard sandstones (hence forming uplands) with alternations of shales and porous grit beds (and in the latter formation some coals). They therefore give rise to an abundance of lime-free surface water and although, owing to their low porosity, they are not good water *bearing* formations,

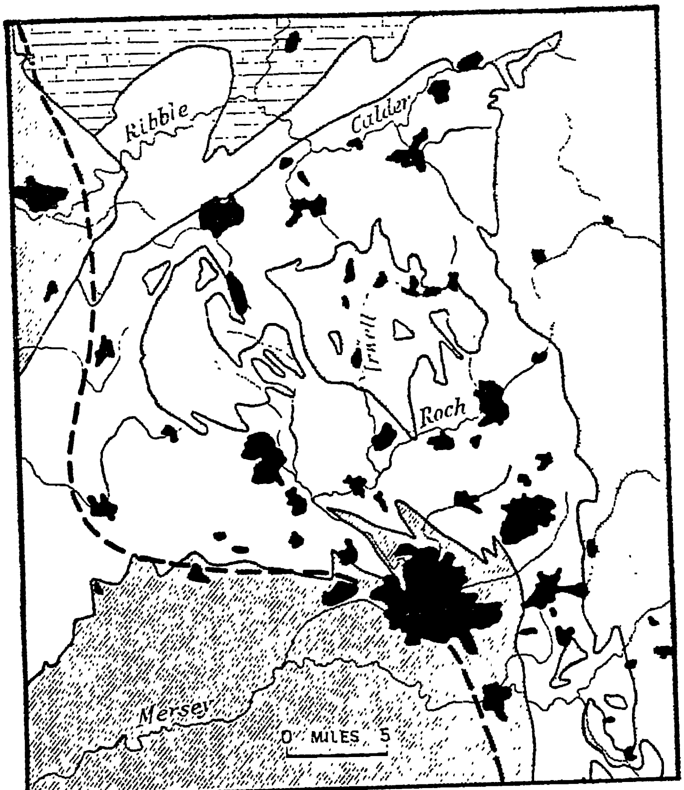

FIG. 217.—The cotton working towns of Lancashire, showing the relation of their position to geological outcrops and soft water supplies.

Carboniferous Limestone outcrop shown on the north; Millstone Grit, dotted (cf. note to Fig. 151); Coal Measures, blank; Trias, lined. The heavy broken line marks the westward limit, according to H. W. Ogden, of soft water (hardness under 10).

the deep narrow valleys which dissect the uplands can easily be dammed in order to ensure copious and constant supplies. The regularity of the stream régime is a result of the comparative evenness of the precipitation through the year (partly, no doubt, due to the dominant orographical character of the rain in a west-facing upland area) and of the thick accumulations of spongy, water-holding peat which cover the moors.

The extent to which the need for soft water, at first for washing and cleaning, bleaching and dyeing, and later to an even greater extent for the chemical bleaching process and for the steam-producing boilers, has limited the outward expansion of the industry, is seen in Fig. 217. Water having a permanent hardness of more than 10 degrees (*i.e.* 10 grains of carbonate of lime, or its equivalent in other lime or magnesium salts, per gallon of water) is very difficult to lather, and this makes for much wastage of soap and chemicals; moreover, the excess of lime is deposited as scale in the boilers and pipes of the power-producing plant. Although water-softening apparatus is now available, the cost of installation and upkeep is not likely to assist in the construction of new mills outside the soft-water area. We thus find that the cotton industry did not develop on the Triassic, drift-covered area of south-west Lancashire, nor on the flanks of the limestone Pennines; the absence of water power in the former region provided a further check to the westward expansion of the industry. The northern boundary of the cotton-working region is probably the result of the interaction of several factors. The more diversified lithology of the rocks underlying the Ribble basin, together with the fact that the Ribble itself rises in one of the most extensive areas of limestone in northern England, render the softness of the water less reliable (since hard spring water from limestone tends to flow more constantly than soft upland drainage water, which tends to concentrate into floods, and thus the hardness of the stream water varies according to season). Moreover, two further hindrances to northward expansion were the absence of coal and the distance from the economic centres of the industry—the port of Liverpool and the Manchester market. Thus, north of the coalfield edge, the only two cotton-working centres of any importance are Preston (deriving its soft water from the Millstone Grit of Longridge Fell) and Clitheroe (similarly supplied by Pendle Hill). Finally, it is noteworthy that the cotton industry has overstepped the flat watershed between the Roch and the Yorkshire Calder, Todmorden and Hebden Bridge being far more devoted to cotton than to wool.

Concerning the coalfield as a factor in the growth of the industry, reference has already been made (Chapter XV) to the nature and occurrence of the seams. It is noteworthy here that the major centres of production were never in the vicinity of the principal cotton towns, but lay south-west thereof, in the Lancashire plain. The Bolton-Rochdale group, and the Rossendale group, especially, are removed from large mines. It is obviously then the mere existence of the coalfield, rather than the geographical distribution of the mining centres, which has been and is now of importance (cf. Chapter XX, p. 466, and Fig. 151). Less importance will be

attached in the future, too, to the actual mining areas, for the use of electrical power transmitted from steam-power stations near the mines is making great strides (*vide supra*, p. 481, *note* 1).

The humidity of the atmosphere in Lancashire, although not the vital factor that it was formerly supposed to be, is a valuable asset.[1] For spinning a high relative humidity is required, as otherwise the threads snap under the strain put upon them in the process of drawing and twisting. Dampness causes the fibres to cling together. Even a slight drop in the relative humidity, due perhaps to an east wind, is sufficient to cause considerable inconvenience, and a long dry spell may prove very costly, for although from very early times—almost in fact from the introduction of the steam engine—artificial steaming or humidifying of the atmosphere has been practised, for long artificially dampened air was not as good as natural.[2] The value of this high humidity has been considerably enhanced by the increasing specialisation in the finer counts, for naturally the finer the thread the greater the liability to break under dry conditions.

Finally, a last result of the geological structure is the abundance of building material, so necessary in an area where great factories have to be erected. The sandstones of the Millstone Grit and Coal Measures have been employed for domestic and factory architecture, and more recently the Coal Measure shales have been dug in large quantities for brick making. Most of the modern mills are red-brick buildings, which give an occasional splash of colour to an otherwise drab and grey landscape.

The development of associated trades is a natural accompaniment of the growth of any large and concentrated industry. It was indeed fortunate for the cotton industry that the principal seat of the heavy chemical industry in Britain should have grown up in the middle Mersey region, backed on the one hand by the saltfield of Cheshire, and on the other by the port of Liverpool, into which flowed the fats for soap making and the pyrites for sulphuric acid. Probably at first the two industries, cotton and chemicals, were inter-dependent, but the vast expansion of the chemical industry has resulted in the textile trades now forming only a small part of the market for the produce of Widnes and Runcorn (cf. Chapter XXIII). The growth of the engineering industry, too, especially that part of it devoted to the manufacture of textile machinery, was a natural corollary of the early inventions. Without it Lancashire could never have continued to lead the world in technical efficiency and in the production of the finest types of cotton fabric (cf. Chapter XVIII).

[1] Ogden, *loc. cit.*

[2] But this is scarcely true now, modern humidifying apparatus is capable of control and an even humidity can be maintained.

The cotton industry would likewise have been stifled through the inadequacy of its transport system had not the railway come to its aid. The bulk traffic engendered by the cotton trade was fast outgrowing the capacity of the canals, and the monopolistic control exercised by the canal owners, the slowness of the transport, and the endless delays due to the locks, and in summer to lack of water and in winter to ice, led a group of merchants in Liverpool and Manchester to embark upon the construction of the railway to connect those two industrial foci (cf. Chapter XXVII). In the

[*Photo: Central Aerophoto Co.*

FIG. 218.—A cotton mill town, Lancashire (Preston).

A creation of the industrial revolution and the Victorian era.

'thirties the high-water mark of canal transport was reached; then railways began to supersede the stage coach and the barge for passenger and freight traffic, and by 1850 almost all the present railways were in existence. The outstanding features of the railway web of South Lancashire are a reflection of the distribution and organisation of the cotton industry—although, of course, it is not the cotton industry alone which has produced them. No less than three main lines connect the market and the port—the direct route across Chat Moss (L.N.W. Ry.), the southern line *via* Warrington (Cheshire Lines), and the northern line *via* Bolton (Lancashire and

Yorkshire). Manchester has a radial web linking it with all the major centres, and an important link joins Liverpool to the weaving centres north of Rossendale. The most recent expression of the dominating position occupied by Manchester is the Ship Canal, completed in 1894, permitting large ocean freighters to dock 35 miles from the Mersey Bar. An increasing *proportion* of the raw cotton imported is being received by Manchester at the expense of Liverpool.

PORTS IMPORTING RAW COTTON

(Million lbs.)

	1913	Average 1927–30	1931	1932	1933	1934	1935
Liverpool	1,690	1,106	744	873	993	865	855
Manchester . . .	383	336	338	389	411	400	425
London	40	22	13	14	29	28	33

Mention should finally be made of the expansion of road transport between the ports, the mills, and the market. Steam and motor lorries carrying, with trailers, from six to ten tons have, by reason of their greater flexibility as transporting media, taken much traffic from the railways. Loading up with raw cotton at the Liverpool or Manchester docks, they can deliver at almost any spinning mill within an hour or two, and are then free perhaps to carry yarn to a weaving mill, and afterwards cloth back to the Manchester warehouse in the same day. Such mobility and speed is impossible for a railway truck.

(*b*) *Scotland.*[1]—The growth of a cotton industry in Scotland, although resting on sound geographical foundations, was largely the result of the coincidence, in time, of two events of historical importance. At the beginning of the Industrial Revolution period flourishing linen and silk industries were already in existence, being especially well developed in the Glasgow-Paisley region (cf. Chapter XXII). Abundant supplies of soft water from the lime-free rocks of the Central Lowlands, a humid atmosphere favourable to the spinning operation, and a "deposit" of labour skilled in the manufacture of fine fabrics, thus provided a suitable ground in which the new industry could take root. Then the American War of Independence, by causing the sudden ruin of Glasgow's extensive trade with the Plantations—especially the tobacco trade—left without employment a vast amount of capital and organising ability which had been gained therein; and it so happened that this period, 1775–80, coincided with the period of the great inventions in the cotton industry which we have already discussed. The

[1] See H. Hamilton: *Industrial Revolution in Scotland*, Chapter VI

manufacture of cotton thus provided a very appropriate new outlet for the capital and skill of the Lowlands. Actually, the use of cotton in fustian making probably began about 1769, and in 1780 muslins began to be made, using Indian spun weft; but it was not until the early 'eighties that the use of Crompton's mule enabled all-cotton cloth to be made from home-spun yarn, and the real boom in the erection of cotton spinning mills occurred between 1785 and 1795.

The widespread nature of the linen industry and the abundance of soft water and water power in most parts of Scotland resulted in the early cotton mills being scattered in many counties, although the Glasgow region naturally exercised a considerable influence by reason of its West Indian traffic (most of the cotton came before 1795 from these islands) and its linen and silk trades, on the location of new enterprises.[1] With the exception of one or two well placed concerns which managed to survive for a considerable period, however (*e.g.* Catrine in Ayrshire, Deanston in Perthshire—both of which still exist to-day) most of the mills outside the Glasgow-Paisley region were comparatively short-lived; distance from the source of raw material (*i.e.* the port) and later from coal supplies, causing their eventual demise.

Just as in Lancashire, a new factor was introduced into the industry in the 'nineties—the steam engine. The expansion of this method of power production was not rapid in Scotland, partly because of the excellent water power facilities which were being utilised, and partly because the engineering industry did not establish itself on the Lanarkshire coalfield as rapidly as in Lancashire, each new mill thus having to make its own machinery. Slowly but surely, however, the steam engine conquered the spinning industry, and the concentration of the mills upon the Lanarkshire coalfield became more marked. By the 1830's nearly all the spinning mills were to be found within 25 miles of Glasgow.[2]

In the weaving branch, of course, domestic labour continued to produce the greater part of the output for some time after the spinning industry had been mechanised, and, as in Lancashire, the weavers enjoyed a period of great prosperity whilst yarn was so cheap. In 1831, although there were nearly 15,000 power looms in the Glasgow district, some 50,000 hand looms were still in use in the villages of Lanarkshire, Renfrew, and Ayrshire, and hand-loom weavers remained an important section of the community until the 'seventies or 'eighties. The early specialisation of the linen and

[1] The first cotton mill in Scotland was erected at Rothesay on the island of Bute in 1779. In 1787 there were 19 water-power spinning mills, distributed as follows: Lanark 4, Renfrew 4, Perth 3, Edinburgh 2, Ayr 1, Galloway 1, Annandale 1, Bute 1, Aberdeen 1, Fifeshire 1.

[2] Spinning mills, 1839: Lanarkshire 107, Renfrew 68, rest of Scotland 17. Glasgow alone possessed 98.

silk industries in fine fabrics naturally gave an impetus to the production of similar fine wares in cotton. Muslins and ginghams were the ordinary goods produced, but over half the looms, in about 1840, were employed in making the famous Paisley shawls (either all cotton, or cotton and silk), fancy muslins and decorated cloths. Here lay the greatest difference between the cotton industries of Scotland and Lancashire. Lancashire was thriving on coarse cotton cloths for the Indian market; the fine fabrics from Glasgow went mainly to the Continent.

The rapid rise of the cotton industry and its concentration in the Glasgow region were accompanied, as in Lancashire, by the growth of auxiliary trades. Pure water supplies and the facilities for importing raw materials gave rise to a chemical industry which could supply the bleaching and dyeing works which naturally sprang up in the wake of the cotton mills.[1] The ease of production of iron and coal resulted in the establishment of an engineering industry; but although at first this may have been intimately connected with the cotton trade, it soon expanded far beyond the limits set by the mechanical requirements of the factories, and took to the railway and shipbuilding branches (cf. Chapter XVIII, p. 406). It was the extraordinary geographical basis of the iron and steel industry, in fact (cf. p. 353) which prevented Glasgow from becoming a rival to Manchester, and which was largely responsible for the gradual decline of the Scottish cotton industry in the second half of last century. Iron and steel came so to dominate the economic life of the lowlands, especially of the Lanarkshire coalfield region, that the cotton industry, built from the very beginning on the rather insecure foundation of specialisation in fine and peculiar wares, and so susceptible to changes of fashion,[2] and unable to take advantage of the expanding Indian and Far Eastern markets, was almost swamped.[3] The geographical suitability of the area for cotton manufacture remained unaltered—but the far greater suitability for iron and steel production resulted in the concentration on these trades at the expense of cotton.

The Present State of the Cotton Industry

(*a*) *Sources of Raw Material.*—The cotton industry in Britain was founded upon supplies of raw cotton from the Near East, as we have seen. Before the end of the seventeenth century, the West Indies began to rival the Levantine regions as the chief source of supply. London was the principal receiving port, most of the

[1] The dyeing industry was introduced into the Glasgow region by James Watt, who brought Berthollet's invention from France. (*Cf.* pp. 479, 520.)

[2] The manufacture of Paisley shawls, for example, collapsed between 1870 and 1880.

[3] *Vide* Hamilton, *op. cit.*, pp. 147–9.

cotton making an overland journey between the capital and Lancashire. Liverpool, although its general trade was growing, was not important as an importer of cotton until the rise of the United States as a cotton-producing region. Towards the end of the eighteenth century Glasgow also began to import West Indian cotton. Little expansion was possible in the supply of raw cotton from these regions, however, while the French were still in a position to intercept cargoes bound for Britain, and it so happened that a fresh source of supply in the Cotton Belt of the newly established United States became available at just about the same time as the Revolution in France temporarily upset the trading and industrial activities of that country. The cotton plant was of some importance in the agricultural economy of Georgia and the Carolinas by about 1790, and the invention of the saw gin, a machine for separating the fibres from the cotton seeds, in 1793, by making the medium-stapled American cottons much more readily usable, gave the signal for a very rapid expansion of cotton cultivation. The Southern States quickly superseded all other sources of supply, and since that time their produce has been the mainstay of the British cotton industry, and every fluctuation in their crop has been reflected in the prosperity or otherwise of the Lancashire mills.[1]

The following table shows the chief countries which send raw cotton to Britain :—

Retained Imports of Raw Cotton
(Million lbs.)

From	1913	Average 1921–25	Average 1926–30	1931	1932	1933	1934	1935
United States . . .	1471	857	838	442	745	777	481	602
Egypt	288	265	249	238	213	295	247	244
India	30	78	78	97	49	103	145	152
Brazil	57	24	20	37	0	14	144	59
Peru	38	72	83	64	64	76	84	61
Anglo-Egyptian Sudan	—	12	45	10	57	35	44	57
Other Countries . .	290	92	370	210	132	233	243	123
Total . .	2,174	1,400	1,483	1,098	1,260	1,433	1,388	1,298

Before the War the United States and Egypt provided about 80 per cent. of the imports. Post-war years, however, have witnessed a serious decline in the actual and proportional imports from the United States, and an increase in the amount received from India, and relatively to the total from other Empire sources.[2]

[1] *E.g.* the American Civil War, 1861–64, or, more recently, the partial failure of the crop in 1921.

[2] In 1927–28 the Empire provided 11 per cent.; in 1928–29, 12 per cent.; in 1929–30, 15 per cent.; in 1930–31, 20 per cent.; in 1931–32, 19 per cent.; and in 1934–35, 20 per cent.

In British territories in Africa the Empire Cotton Growing Corporation has done much to encourage the growing of cotton by native producers, though the plantation system has not proved successful. The result is that in 1931–35 the United States and Egypt only accounted for 65 per cent. of the total imports. Brazil and Peru continue to send between them nearly 10 per cent. of the total.

Raw cotton varies enormously in quality. The important factors determining quality include length and regularity, fineness, lustre, softness, strength, colour, and cleanness. The fibres vary in length from about $\frac{1}{2}$ inch to $2\frac{1}{4}$ inches. In America, when the fibres are less than $1\frac{1}{8}$ inch in length, the cotton is referred to as short stapled; long-stapled cottons exceed $1\frac{1}{8}$ inch. In other countries the terms are relative. We may classify the various grades of raw cotton into three principal groups:

(*a*) Group I or Fine Cottons, including:

True Sea-Island, produced only in small quantities in the small islands off Georgia (United States) and in some of the smaller West Indian islands;

Georgia and Florida Sea-Island, generally grown on the coast lands of those States near the sea. Of roughly equivalent quality are the finest Egyptian cottons (Sakellaridis);

American "Long Stapled Uplands," grown mainly in Louisiana and Texas ($1\frac{1}{4}$ to $1\frac{3}{4}$ inch staple). Of about the same quality are Peruvian and the best West African cottons.

(*b*) Group II or American "Uplands"—the commonest and most abundant quality. Uplands are classified according to the International (U.S. official) standards into eight grades. In Group II are included much of the South American cotton as well as long-stapled Indian[1] and Russian.

(*c*) Group III or Short Native Indian, Russian, and Chinese cottons—short-stapled and harsh.

In general, it may be said that the longer the staple of the cotton the finer the yarn and fabric that can be produced from it. Yarn is graded in "counts." A count is the number of hanks, each 840 yards in length, which go to make up one pound avoirdupois. Thus the finer the yarn the higher the count. Ordinary American cotton of $\frac{7}{8}$ inch staple will produce yarn of about 20's counts, but the best Sea Island may give a yarn of almost spider's web fineness, counting more than 300 hanks to the pound, and counts of up to 200 are produced from the best Egyptian cottons.

(*b*) *Processes in the Cotton Industry.*[2]—The principles of cotton manufacture resemble those which we have already described

[1] The bulk of the cotton imported by Britain from India does not exceed $\frac{7}{8}$ inch.

[2] See *The Cotton World*, ed. J. A. Todd (1927), p. 191.

for the woollen industry (p. 459). The main processes are as follows :—

(1) After unbaling the raw cotton is passed through mixing and cleansing machinery (in which spiked rollers and air suction play important parts).

(2) Next, the carding machines give a final cleansing, remove the short unusable fibres [1] (*vide infra*) and deliver the cotton in slivers—ropes of clean separated fibres, held together by their natural cohesion.

(3) In order to remove irregularities of thickness and weight, several slivers are combined in a "drawing-frame" and drawn out into one, so that the fibres take up a position parallel to each other.

(4) The drawn slivers are passed through a succession of machines ("fly frames") which gradually reduce their thickness and prepare them for receiving the twist which will make them into yarn.

(5) One of two methods may be used in the spinning process. The simplest apparatus is the ring-frame (derived from Arkwright's "water-frame"), which spins continuously and is used chiefly for warp and coarser yarns. More complicated, needing more attention (for its operation is intermittent), but producing softer and better yarn, is the self-acting mule (derived from Crompton's invention).

(6) "Doubling" (twisting together of spun yarns) may be performed to ensure an even count being produced or to give strength to warp yarn; and all yarn destined for use as sewing thread, or in the lace and hosiery trades, is doubled.

(7) Weft yarn needs little or no further preparation, but the "twist" (warp yarn) must be transferred from the cops or bobbins of the spinner on to a winding frame ready for assembling on the warper's beam.

(8) After "beaming" the yarn on the beams is passed through boiling size and steam dried.

(9) The beam is then mounted in the loom, and weaving can commence.

(10) The "grey" woven cloth is then either disposed of as such, or is subjected to several finishing processes. Apart from dyeing, bleaching, and printing, the more important of these are calendering and mercerising. The calendering machine gives a smooth and shiny finish to the cloth. Mercerising consists of steeping cotton yarn or cloth in a bath of caustic soda in such a way that the shrinkage which would ordinarily result from such treatment is prevented. It produces a lustre almost equivalent to that of silk.

[1] In the production of fine yarns from long-stapled cotton special combing machinery is employed for this purpose between the carding and drawing processes

The short fibres removed by the carding machines are known as waste. They are worked up (sometimes mixed with short-stapled Indian cotton or even with wool) into coarse yarn (5's to 10's counts) for use in the manufacture of sheetings, blankets, towels, dusters, lamp wicks, and a host of other miscellaneous products.

(c) *Geographical Distribution and Specialisation.*—The extraordinary centralisation of the cotton industry in South Lancashire has rendered possible a degree of specialisation that is without parallel in any other branch of manufacture. Not only have the various processes of the industry tended to separate, financially and physically, but the relatively unfavourable situation of Lancashire with regard to raw materials and foreign markets has produced a further specialisation in the finer varieties of fabrics and in products for particular markets. The focus of this centralisation from the very beginning has been Manchester; but from being the principal producer the city has changed its rôle to that of commercial and financial centre. An industry which imported all its raw material from abroad and exported the bulk of its output naturally needed a greater amount of commercial organisation than an industry based upon local supplies and local markets; and Manchester, excellent route centre that it was, assumed the functions of bank and warehouse. The rapid growth which such a position entailed, combined with the city's increasing importance as a port, has had the effect of raising land values to such an extent that many of the older mills have migrated to the outer suburbs and to the smaller towns. Manchester is still the centre of the industry—no longer the producing centre, however, but the commercial centre.

Two of the outstanding features of the Lancashire cotton industry are the extreme specialisation of its constituent parts, and the feeble development of integration of any kind. At least six types of firm may be recognised: (1) the Liverpool merchants and brokers; (2) the spinners; (3) the yarn merchants; (4) the manufacturers (weavers); (5) the dyers and finishers; (6) the piece-goods merchants. Many of the producing firms further limit their activities, confining themselves, for example, to fine or coarse yarn, special fabrics, bleaching, sizing, or dyeing; whilst the activities of the Manchester merchants are similarly limited to certain markets.[1]

The distribution of the three main branches of the cotton industry, spinning (including carding), weaving or "manufacturing" (including winding), and finishing (bleaching, dyeing, and calendering) is indicated graphically in Fig. 219. The economic basis of the separation of spinning and weaving, apart from the historical reasons given, is not difficult to discover. It is due to two main

[1] Chapman, *op. cit.*, Chapter VIII; G. C. Allen, *British Industries*, pp. 227–50; *Survey of Textile Industries*, pp. 15–30.

causes. In the first place it is the result of the ever increasing range of yarns and fabrics which can be produced. Few firms, without being unwieldy and uneconomic, could possibly manufacture all

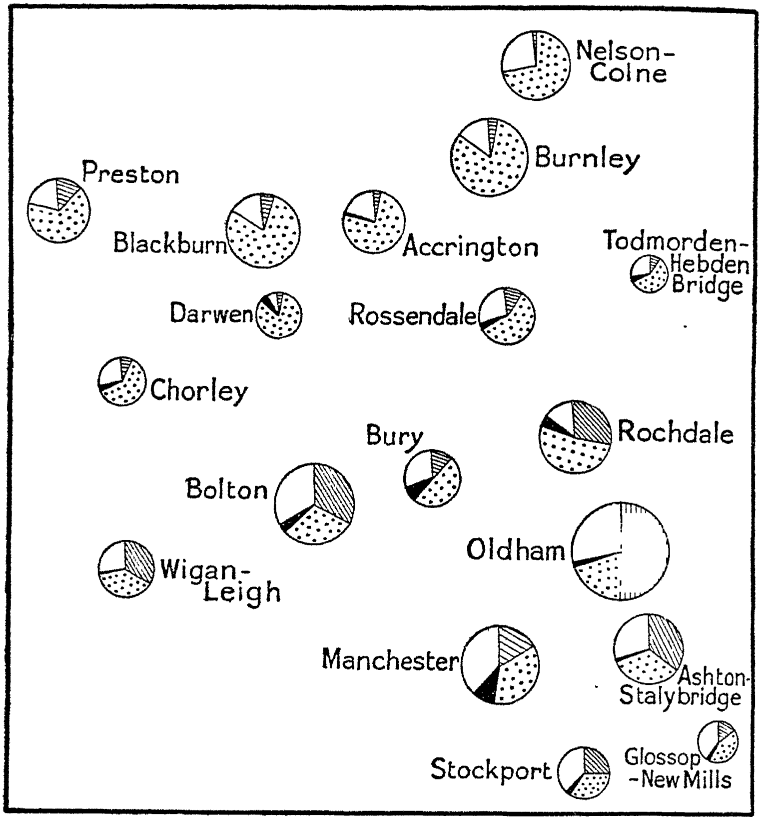

FIG. 219.—Distribution of Textile occupations in the cotton-working area, 1921.

Circles are proportional in area to number of people employed; thus Oldham = 66,000, Darwen = [illegible]. The sectors of the circles represent the proportion of the total engaged in the various branches of the industry. Ruled = Carding and Spinning (Census groups 363,365); dotted = Winding and Weaving (groups 367,370); black = Dyeing and Calendering (groups 381,384); blank = all other cotton-working occupations. The people have been grouped around the principal towns; thus Bolton includes Bolton C.B., and the parishes of Farnworth, Kearsley, Little Lever, Turton and Little Hulton; Rossendale includes Bacup, Rawtenstall, Haslingden and Ramsbottom. Notice the feeble development of spinning in the northern area, the prominence of weaving in the so-called "spinning" area of the south, and the importance of the finishing trades in the Manchester—Bolton—Bury region.

the many varieties of yarn and stuff, and so the business units have tended to remain small, specialising in certain types of product only. Secondly, the organising capacity necessary in the spinning industry is very different from that required in weaving.[1] The

[1] Chapman, *op. cit.*, pp. 161–4. Cf. Jewkes, *loc. cit.*, pp. 105–6.

spinning branch is concerned with a narrower range of products, is more adaptable to large scale production and horizontal integration, and depends for its market not only upon the local weaving industry but also upon the fairly stable cotton industries of the Continent. The weaving trade, on the other hand, deals in a multitude of different styles of fabric, employing many different types of yarn, and depends largely for its prosperity upon a fluctuating, almost world-wide, market, and upon the ability to foresee and cater for changes of fashion, both at home and abroad. There are still many firms which, whether through sheer momentum or through the desire to ensure the quality of the yarn which they employ, conduct both spinning and weaving operations, but the majority confine themselves to one branch only. The number of separate firms engaged in weaving is much greater than the number in the spinning trade. This is partly due to the greater tendency for amalgamation amongst spinning firms and partly to the extreme specialisation of the weaving trade.[1]

The spinning industry continues to be located principally in the early cotton-working area—the region of the valleys tributary to the Irwell and the Mersey, *i.e.* to Manchester. Although the "horseshoe" of towns stretching from Wigan and Leigh *via* Bolton, Bury, Rochdale, Oldham, and Stalybridge to Stockport is primarily devoted to spinning, weaving is by no means absent, and the spinning industry shows much specialisation which is incapable of geographical explanation. Thus Oldham deals mainly in medium staple American cotton, producing yarn of 20's to 60's counts. Rochdale's trade is similar. Bolton and Manchester, on the other hand, spin finer yarns from the best American, Egyptian, and Peruvian cottons; and in the Stockport district doubling becomes an important separate branch of the industry. North of the Rossendale upland spinning is of very small importance compared with weaving.

The weaving industry is far more widespread than the spinning, and besides being dominant north of Rossendale, it employs as many or more people than spinning in most of the towns south of the upland, with the exception of Oldham. Here again we find certain towns devoted to certain types of fabric. Within the Manchester province perhaps the chief weaving activity is concerned with the manufacture of goods from "waste," as at Rochdale and Heywood and in the Stockport-Stalybridge districts, but Oldham still retains something of the old fustian trade, and Bolton produces quilts. The towns in the Rossendale valley specialise in sheeting (made mostly from "waste"). North of the Fells we find Preston

[1] Number of firms engaged in 1924 (*Worrall's Directory*, quoted in *Survey of Textile Industries*, pp. 24–6), spinning only: 620; spinning and weaving: 232; weaving only: over 900.

making fine shirtings, Blackburn and Accrington concentrating mainly on "dhooties"[1] and other cheap cloths for the Indian and Chinese trade, Burnley on long lengths of narrow cloth destined for printing, Nelson and Colne on "fancy" fabrics such as sateens, poplins, and brocade.

The finishing industry, comprising bleaching, dyeing, and calico printing and numerous finishing processes, such as mercerising and calendering, remains centred in the Manchester province where it originally grew up. It has been held there by the favourable situation with regard to pure water supplies, and by proximity to the great warehousing centre. The works are to be found alongside the streams which flow down from the Rossendale Fells and the Pennines, the rivers Goyt, Roch, Irwell, and Bradshaw Brook being especially important in this respect.[2] The chief centres are Manchester-Salford, Stockport, Bury, Bolton, and Rochdale (with Littleborough) and the smaller towns just north of Manchester—Radcliffe, Whitefield, and Middleton.

Those centres of cotton manufacture lying just off the edge of the main region in Derbyshire and Yorkshire for the most part resemble, in their industry, the Lancashire region which lies nearest. Thus the Glossop-New Mills group in north-west Derbyshire is devoted, like Stockport, to spinning, to the weaving of cloth from waste, and to the bleaching and dyeing industry. Further north the Saddleworth-Dobcross area has specialities more akin to those of Oldham. A great tongue of the cotton industry stretches from Rochdale into the Calder valley of the West Riding, and whilst Todmorden and Hebden Bridge are more "cotton" than "woollen" towns, numerous woollen centres further east also indulge to a certain extent in the manufacture of cotton. Huddersfield and Halifax are the chief of these, but Sowerby Bridge, Elland, and Brighouse each have more than 10 firms engaged in the cotton industry. The main branches are cotton-doubling and weaving. Spinning is not developed to any extent, possibly owing to the lower average of relative humidity on the eastern side of the Pennines. Farther north still, the weaving industry of Nelson and Colne has overflowed into the Aire valley. Skipton is the principal centre, but Bradford also has a number of cotton mills, and others are scattered in the small towns which lie in the valley between these two—*e.g.* Keighley and Bingley. In this region weaving, especially of the Nelson-Colne specialities, is the principal activity.

Rather further afield we find interesting "outliers" of the cotton industry in the region around the southern end of the Pennines, where the manufacture has survived because of the existence of

[1] Long, narrow strips of flimsy cloth worn by male Hindus as pantaloons.

[2] Many of the works may be seen on the Ordnance Survey 1-inch map, sheet 36

allied industries. Scattered mills in the Macclesfield district of Cheshire deal in spinning and doubling and especially in bleaching, dyeing, and mercerising, the presence of the silk industry probably having encouraged the last named activity. In Nottinghamshire Leicestershire, and Derbyshire, the existence of the lace and hosiery trades has had much to do with the survival, as at Nottingham, Derby, Mansfield, Long Eaton, and a few smaller centres, of cotton doubling and the manufacture of sewing thread.

The cotton industry in Scotland is but a shadow of its former self. The spinning branch has almost disappeared (except, of course, for the important manufacture of sewing cotton), and yarn is now obtained from Lancashire. Three types of activity remain. The last witness of the former trade in high-quality goods is the manufacture of poplins, muslins, ginghams and fine shirtings, still carried on in Glasgow. Paisley shawls have given place to sewing thread in the making of which some 10,000, mostly women, are employed.[1] Lastly, the finishing trades still retain some of their former importance in the Glasgow region, in the Vale of Leven (calico printing), and in north Ayrshire, by reason of the abundance of pure water and the proximity of the chemical industry—although most of their work is now performed upon fabrics which have been woven in Lancashire.

A few mills at Belfast continue to spin cotton, chiefly for admixture with flax in the production of special types of thread and table linen.

The Progress of the Cotton Trade

The British cotton trade experienced an almost uninterrupted growth from the period of mechanical inventions until the Great War, as we have seen. In the quinquennium before 1914 the enormous total of over 2,000 million lbs. of raw cotton was being imported annually (cf. p. 490). Since 1918, however, the cotton manufacture has suffered more from the effects of foreign competition, and of the world-wide depression, than perhaps any other industry, as the tables given below will show.

The inability of Britain to retain her hold of the world's cotton market during the war years allowed Japan to step in and capture much of the trade in the Far East, and the expansion of the industry in that country, and in India, where economic protection has fostered the development of a cotton manufacture, has done much towards increasing the problems and reducing the trade of the Lancashire producers.

Just as in iron and steel and in shipbuilding, we find that the world supremacy of the British cotton industry has been dwindling

[1] Enough thread is made each week in Paisley to encircle the earth 88 times! Employment, 1931: 10,773, of whom 7,941 were female.

for half a century. In the early 'eighties Britain possessed over half of the world's spindles. By 1914 the percentage had fallen to below 40, and in 1927 was little more than 33.[1] The advantage derived from being the first in the field is now lost, and some of the geographical factors which helped to localise the industry in Lancashire no longer operate. Cotton industries have grown up nearer to the plantations in the United States and in India and the Far East, and Lancashire has, as it were, cut her own throat by fitting out these new industries with machinery and so preparing them to compete with the Lancashire products for their own markets. It cannot be denied, however, that although the machinery industry in Lancashire has helped foreign competition, it has been a most valuable asset to its own region in providing on the spot the materials and the technical skill required in the development of new machines for an ever-increasing range of textile fabrics. The expanding industries in better situated areas have rendered it increasingly uneconomic for Lancashire to try and compete in the market for cheap and coarse cloths, and as a result specialisation has taken place in finer fabrics. Thus in 1927 Great Britain possessed 67·5 per cent. of the world's mule spindles, but only 13·7 per cent. of the ring-frame variety—a reliable indication of the higher quality goods and the greater amount of skill necessary to produce them.[2]

The following tables present in statistical form the gloomy picture of the post-1918 cotton trade :—

EXPORT OF COTTON YARNS

(Million lbs.)

Country	1913	Average 1921–25	Average 1926–30	1931	1932	1933	1934	1935
Germany	52	35	41	33	29	30	19	30
Netherlands	39	44	35	23	18	13	14	15
Switzerland	9	8	8	6	4	4	5	5
France	5	5	5	3	1	1	0	1
Belgium	5	5	7	4	4	5	4	5
India	37	26	19	11	15	11	9	11
Other countries	63	46	52	54	70	71	79	75
Total	210	169	168	134	141	135	130	142

[1] *Survey of the Textile Industries*, pp. 12–13, 150–51.
[2] *Survey of the Textile Industries*, p. 13.

EXPORT OF COTTON PIECE GOODS BY VARIETY

(Million Linear Yards)

Variety	1913	Average 1921–25	Average 1926–30	1931	1932	1933	1934	1935
Grey, unbleached	2,357	1,252	943	289	357	357	344	323
White, bleached	2,045	1,306	1,228	631	772	649	599	589
Printed	1,231	681	556	322	451	417	442	455
Dyed in the piece	1,151	750	760	456	594	585	578	535
Coloured cottons	290	185	153	90	125	109	96	111
Total	7,075	4,179	3,667	1,790	2,303	2,117	2,060	2,013

EXPORT OF COTTON PIECE GOODS BY COUNTRIES

(Million sq. Yards)

Country	1913[1]	Average 1921–25	Average 1926–30	1931	1932	1933	1934	1935
India	3,057	1,393	1,382	390	599	486	583	543
Egypt	267	214[3]	137	71	82	64	44	36
China	573[2]	244	141	41	73	34	15	8
Argentina	199	146	131	93	116	146	161	134
Australia	168	169	162	122	167	146	142	118
Total (sq. yds.)	7,075	4,021	3,579	1,716	2,197	2,031	1,994	1,948

[1] Linear yards.
[2] Exclusive of Hong Kong, Macao and leased territories—elsewhere these are included.
[3] 1923–25 only.

Between two-thirds and three-quarters of the yarn spun is exported, and quite a large proportion of the remainder eventually finds its way out of the country as lace or hosiery (cf. Chapter XXII). The yarn trade, depending more on the Continental market than on the Asiatic countries, has not suffered very severely—for the European cotton industries, like our own, are fairly old established, are dependent on raw material imported from a distance and have had more or less to specialise. The only serious decline is in the amount sent to India.

Turning to piece goods, the trade of the post-war years reveals an unparalleled depression, only slightly relieved by a somewhat better period about 1924–5 and descending to almost unfathomed depths in 1931. When it is remembered that about 85 per cent. of the output is normally exported, the seriousness of this position may be realised. Here again it is the cheap markets which have been lost, the export of grey cloth to the Far East having almost disappeared, and the Indian market dwindling owing to Japanese competition and the expansion of India's own industry.

PORTS EXPORTING COTTON YARN AND GOODS
(Million £'s)

	1913	Average 1927–30	1931	1932	1933	1934	1935
Hull	5·2	9·9	6·0	5·7	6·3	5·8	5·9
Liverpool	71·3	67·7	26·0	32·0	28·7	29·8	32·2
London	9·9	9·7	5·7	6·8	6·9	6·6	6·0
Manchester	14·0	15·0	5·5	5·8	4·6	4·2	4·4
Southampton	6·2	7·8	3·4	3·4	3·7	3·3	2·9
Glasgow	5·8	6·7	3·0	3·6	3·3	3·7	3·3

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CHAPTER XXII

THE TEXTILE INDUSTRIES : OTHER TEXTILES[1]

THE textile industries, other than wool and cotton, and the secondary industries, fall naturally into two groups : (1) those depending mainly for their raw material upon the products of the major industries, cotton, wool, and worsted—that is, the manufacture of lace and all kinds of knitted goods which come under the general term "hosiery" or, to use the convenient American term, "knitwear"; (2) those depending upon home-grown fibres or upon material imported from abroad—*i.e.* the linen, jute, silk, and rayon trades. This division is not a hard and fast one, however, for outside the comparatively isolated and independent linen and jute industries there is a great deal of interdependence between the lace and hosiery trades and silk and rayon manufacture. If we examine the geographical distribution of the various branches, we shall find that several different types of factors have been involved in their localisation.

(1) In the case of linen, proximity to flax-growing areas led originally to the rise of Ireland and the Scottish Lowlands as manufacturing regions. In the Lowlands the growth of other textile occupations and of heavy industries in the west resulted in the confinement of the linen trade to the eastern region—a situation confirmed by the ease of importing flax and hemp from the Baltic countries. In Ireland the events of the Industrial Revolution conspired to localise the industry upon Ulster.

(2) The jute industry attached itself, quite naturally, to the allied linen and hemp trades of the Dundee province,[2] and it has attained but small dimensions elsewhere.

(3) The localisation of much of the silk industry in south-east Cheshire and north-west Staffordshire is not easily explicable on a purely physical basis. Its expansion is due to the pre-existence of a textile smallware and button-making trade, combined with facilities for water-power development.

(4) In Leicestershire, Nottinghamshire, and Derbyshire, the lace and knitwear industries are a result of specialisation in an area which from very early times has been associated with the woollen and worsted trades, and parts of which, owing to the

[1] By S. H. Beaver.

[2] It was a Dundee manufacturer who, during a temporary shortage of hemp supplies, experimented with jute as a substitute.

presence of water power, had developed silk manufacture or the spinning of cotton.

(5) The artificial silk industry hangs, like a satellite, on to pre-existing textile industries by reason of its recent growth. Demanding a labour supply used to textile working operations, it has naturally attached itself to those areas where such labour could most easily be obtained, and consuming large quantities of imported raw materials and of chemicals, it is little wonder that the chief area of its growth should have been Lancashire, with the West Riding, the Nottingham-Leicester province, and the Macclesfield area as subsidiary regions.

(6) Finally, there are numerous isolated centres of the minor textile industries to be found, as in East Anglia, in the West Country, and in south-west Scotland, where certain specialities are all that remain of once flourishing trades in wool and worsted, silk, or cotton.

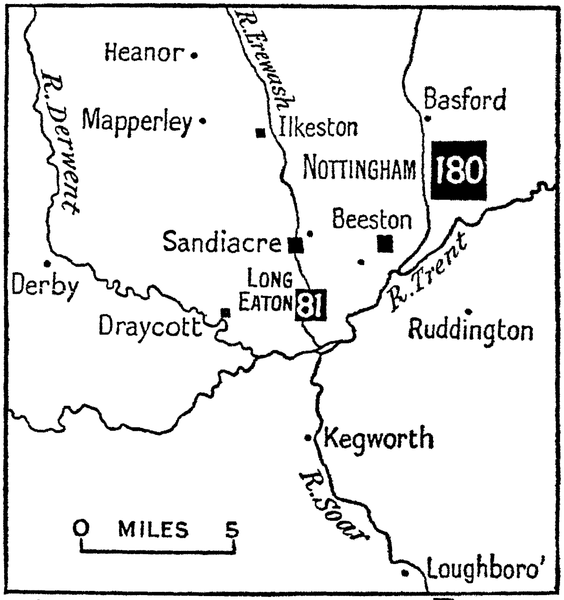
With the exception of artificial silk, which is a product of the twentieth century, all the minor textile industries have long histories. Many features of their early distribution are inexplicable except by the chance settlement of Flemish or other foreign craftsmen; and the geographical and historical factors which contributed to their development in most cases have long since ceased to operate. Without going into an immense amount of historical detail, then—a task which is here impossible—it is difficult to give more than a sketchy account of their origin and growth; and many of the curious features of their distribution must be passed over merely as examples of industrial momentum.

Lace.[1]—Lace was being made in Nottingham, chiefly as a female domestic occupation, in the sixteenth century, and a fillip was probably given to the trade by the arrival early in the seventeenth century of skilled artisans from Flanders, who introduced the working of pillow lace.[2] Little progress was possible, however, until the invention of mechanical aids to manufacture. Three mechanical appliances have probably done more than anything else towards developing the possibilities of lace making. Between 1770 and 1790 numerous attempts were made to adapt the stocking frame of the hosiery industry to the production of new meshes, with the result that by 1810 some 15,000 people were employed in lace working. The invention of the bobbin-net machine by Heathcote in 1809 gave a further impetus to the industry, and during the next twenty years the population of Nottingham and its surrounding villages rose from 47,000 (1811) to 79,000 (1831). Then, in 1834,

[1] See *Victoria County History, Nottinghamshire,* II, pp. 358–363. Also W. Felkin: *History of Machine-wrought Hosiery and Lace Manufactures,* 1867 (very detailed).

[2] Pattern produced by passing thread round pins stuck in a cushion or pillow.

Levers adapted the Jacquard principle to the lace-frame, thus enabling patterns to be produced mechanically instead of being sewn in by hand. During this period the bulk of the work was of a domestic nature, and large numbers of children were employed in preparing the material for their parents. Most of the cotton yarn used came from Manchester, but the doubling was done in Nottingham. The factory system developed but slowly,[1] and the (now



• *1 to 4 Firms*, ▪ *5 to 9 Firms*, ■ *10 to 15 Firms*, 81 *Over 15 Firms*

FIG. 220.—The lace-making province of the Nottingham area.

defunct) system of hiring out machines to workpeople has resulted in the existence, within the industry, of a great number of small firms, several of which are frequently to be found, renting their floor space and power, within a single mill.

The lace trade has, of course, been subject to great fluctuations in accordance with changes of fashion, and it may be said that on the whole it has tended to decline since the Victorian era.[2] A remarkable concentration upon the Nottingham region has been its outstanding feature almost from its inception, an excellent example of the cumulative growth of an industry (Fig. 220). After the city of Nottingham, Long Eaton is the next important centre, but

[1] In 1862, of 120,000 people employed in the lace industry, only 4,000 came under the notice of the Factory Acts.

[2] Employment in lace industry—1907: 25,000; 1924: 17,000; 1930: 14,000.

Sandiacre, Beeston, and numerous other small towns also participate.[1] With the exception of a few isolated west country mills (*e.g.* Chard, and Honiton) the only other noteworthy region is Ayrshire, where lace making, principally of curtain nets, has developed out of the specialised and declined cotton industries of the Glasgow region, which we have already described. Newmilns and Darvel—old water-power sites on the Irvine river—are the most important centres.

Knitwear.—The present-day "hosiery" industry deals with such a variety of products that hosiery proper now forms only a relatively small part of it, knitted underwear and outer garments (pullovers, bathing suits, even frocks and costumes) providing a constantly expanding market. It seems advisable, therefore, in order to avoid confusion of terms, to designate this industry "knitwear." For the first 300 years of its existence, however, the industry was primarily devoted to the production of hose.[2] This hosiery manufacture, making use of worsted and silk, dates from the invention—or perhaps perfection—of the knitting frame, probably by William Lee, of Woodborough, near Nottingham, about 1589. It grew up, slowly replacing hand knitting, in Nottinghamshire and in the adjoining counties of Leicester and Derby—possibly aided by the local production of worsted yarns from the long-woolled Leicester sheep—and also in London, where no doubt the proximity of the silk industry (*vide infra*) and the great local demand for all kinds of clothing were responsible for its progress. The London industry began to decline from about 1730, and most of the machines, possibly because of cheaper labour or cheaper rents, found their way to Nottingham and Leicester. Strutt's invention of a machine for producing ribbed hose, in 1758, gave an impetus to the trade, especially in Derby, in which town the machine was first erected. The three principal centres became concerned with different types of hosiery. Nottingham was the first to make cotton stockings from Indian spun yarn, in 1730, and its later connection with Arkwright, Hargreaves, and the early cotton-spinning industry (cf. Chapter XXI, p. 477) made it the chief cotton-hosiery town, although silk was also employed to a large extent. Derby, the home of the first English silk mill (*vide infra*), developed the manufacture of silk hose; and Leicester, always more concerned with long wools than with cotton or silk, specialised in worsted hosiery.

The present-day manufacture of knitwear forms an interesting link with the cotton, woollen, silk, and rayon industries, for the finished or semi-finished products of those trades form its raw

[1] K. C. Edwards: *Geographical Factors in the Development of Nottingham.* Thesis approved for the degree of M.A. in the University of London (unpublished), 1930. Idem: "Nottingham." *Geography*, XX, 1935, 85–96.

[2] *Victoria County History, Nottinghamshire*, II, 352–358: Felkin, *op. cit.* F. A. Wells: *The British Hosiery Trade: its History and Organisation.* Thesis approved for the degree of Ph.D. in the University of London (unpublished), 1931 (see especially Chapters 1 to 3).

material. The introduction of trousers at the expense of knee-breeches almost killed the silk-hose business, but the cheapening of the manufacture of silk and its use, together with artificial silk in the production of ladies' hosiery, provided a welcome revival. The use of cotton, wool, silk, and artificial silk for knitted underwear, and of wool especially for outer garments, has greatly expanded the market for knitwear, and the growth of the industry has continued during the past decade, despite the industrial depression, until the number of people employed is close upon 100,000 (see table on p. 442). The "knitwear province" is shown in Fig. 221. Dominated by Leicester and Nottingham, the industry is seen to be grouped about four nodes. In the south, Leicester and Hinckley are the principal centres, together with the Wigstons and numerous villages south of Leicester. In the lower Soar valley, Loughborough, Shepshed, and a number of small villages are engaged in the industry; and Nottingham is the focus of the trade in the Erewash and Leen valleys. The last, and smallest, group centres on Sutton-in-Ashfield and Mansfield. At Derby the industry is almost non-existent: with the decay of the silk industry and the growth of engineering, it has gradually declined. As a broad generalisa-

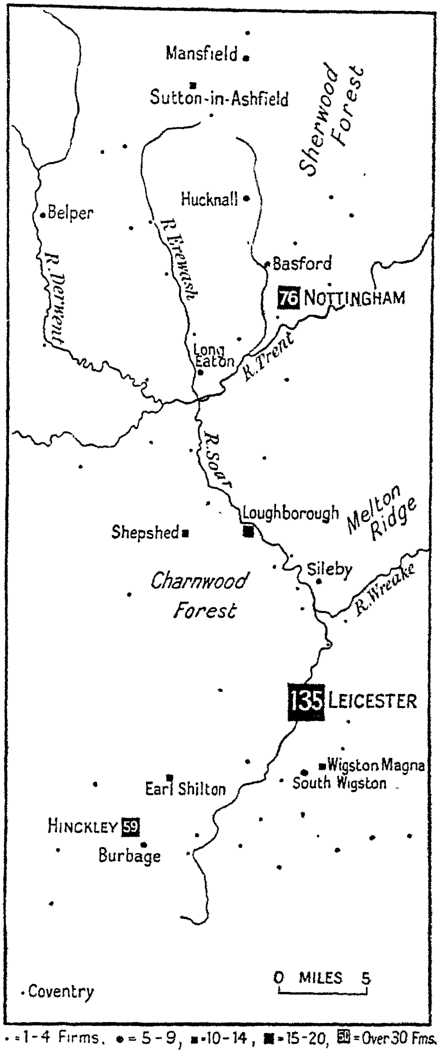


FIG. 221.—The knitwear province of the south-east Midlands.

tion, it may be said that the northern half of the province (the Nottinghamshire-Derbyshire portion) is as much associated with silk as with wool in its hosiery manufacture; the southern portion (Leicestershire) has always been concerned rather more with the use of woollen and worsted yarns. Into further detail than this it is impossible to enter.

Outside this main knitwear province, several other centres of the industry are to be found, mainly in association with other textile trades. Several towns in south Lancashire and the West Riding—Manchester and Keighley are the chief—have knitting mills, as have also the silk-manufacturing centres of Cheshire and Staffordshire—Macclesfield, Congleton, and Leek. In Scotland, Glasgow, Kilmarnock, and Stewarton, together with numerous other Ayrshire towns, carry on a trade which has developed out of the decayed cotton industry of that area; and Hawick has developed woollen knitwear as a sideline to its tweed-cloth industry. Numerous other towns in England and Scotland have small knitwear factories—for bulky raw material is not required, and steam or electric power is only needed on a comparatively small scale.

We turn now to a consideration of the minor textile fibres and the industries based upon them.

Linen.[1]—Flax-growing and the manufacture of linen have been carried on in England, Scotland, and Ireland, and since the industries in each of these countries have had little relation to one another it will be convenient to treat them separately. In each country, however, we shall find that little is known of the origin of the industry, that a considerable advancement was brought about by the influx of foreign refugees, and that parliamentary action, in the form of duties, and historical events, such as the American Civil War, have also contributed to the development of the industry.

England.—Flax was certainly being grown in England in the twelfth century, and late in the fourteenth century a colony of linen weavers, brought by Edward III from the Netherlands, was settled in London; in the fifteenth century Norwich was the centre of the linen trade. Little expansion was possible, however, whilst the woollen industry was receiving such careful attention from the government; no encouragement was given to linen lest it should interfere with the wool trade, and it was not until the rise of the cotton manufacture with its accompanying demand for linen warp yarn, that any great advance was made. Flax growing and linen manufacture were domestic industries, scattered over many parts of the country, notably in South Lancashire, but the quality of the product was poor, largely owing to inadequate knowledge of, and lack of care in, the preparation of flax, and in consequence a great deal of fine linen was imported from France. The introduction

[1] See A. S. Moore: *Linen* (1922).

of spinning machinery in 1787 [1] and the development of steam power after about 1820, resulted in the concentration of the industry in the West Riding, where it reached its maximum in the 'fifties. Leeds alone possessed nearly half of the 441,000 spindles in England and Wales in 1856. The increasing dominance of the wool-textile industry, and the much greater development of linen and its allied fibres in Ireland and Scotland, led to the decline of the Yorkshire industry; and at the present time the manufacture of linen in England is practically extinct.

Scotland.[2]—Linen was the principal export of Scotland in the sixteenth century, and its manufacture was a widespread domestic occupation. After languishing for a period, it experienced a considerable revival in the eighteenth century after the union with England, largely as the result of state encouragement. A board of trustees was set up in 1727, with funds and power to help flax growing and the linen trade—and this remained in existence for nearly a century. A little colony of French weavers from St. Quentin was established at Edinburgh in 1729, and later, Irishmen and Dutchmen were brought to Scotland to teach improved methods of production and manipulation of flax and linen. At first the product was of coarse quality, and most of the export went to the American Plantations, but from the 'forties onwards finer varieties of linen cloth began to be copied from our German competitors. The domestic manufacture of the period was widespread, but with the growth and capitalisation of the industry certain divisions began to be apparent, much of the spinning being done in the northern counties (*e.g.* Banff, Aberdeen) whilst the weavers, although very scattered, tended to congregate in the commercial and finishing centres of the Lowlands, where, as at Perth, Glasgow, Edinburgh, Dumbarton, and several places in Fifeshire, large bleaching fields were laid out. To an increasing extent, too, the eastern part of the lowlands—Forfarshire (Angus) [3]—began to specialise in the coarser types of cloth, whilst Lanarkshire and Renfrew developed the manufacture of French lawns and cambrics,[4] using imported yarn.

The phenomenal growth of the cotton industry in the western portion of the Lowlands during the last 20 years of the eighteenth century had a profound effect upon the linen trade. The manufacturers of fine French and Italian varieties of cloth in the Glasgow-Paisley region were the first to take up the new fibre, and the result was an almost complete extinction of the linen industry in that area. Just at this period, however, flax-spinning machinery was introduced,

[1] First machine erected in 1787 at Darlington.
[2] See Hamilton, *op. cit.* Chapters IV–V.
[3] *E.g.* Dunfermline (Fife), long renowned for table linen.
[4] As late as 1767, 40 skilled craftsmen were brought from France to teach the spinning of fine yarns, and settled at Anderston.

and the linen industry in the eastern counties, aided by the presence of water-power, and, after the application of steam power, of coal, entered upon a period of rapid growth, in the 1820's and 30's. The county of Angus, with Dundee as its chief town, soon became the most important, with the adjoining county of Fife not greatly inferior. In 1836 Scotland possessed 170 flax-spinning mills (80 per cent. of them in these two counties) employing over 13,000 people. The decline of domestic spinning was not paralleled by a similar contraction of the home weaving industry. Flax fibres are inelastic and were not easily worked by mechanical power, so that, although attempts were made to introduce power looms in the 'twenties, their adoption was not general until after 1850, when Dundee, Coupar Angus, Brechin, Kirkcaldy, Montrose, and Aberdeen became important weaving centres. The American Civil War, by almost strangling the cotton trade, gave a distinct fillip to the manufacture of linen, but the prosperity was short-lived, and a steady decline set in. Possibly aided, however, by the allied jute and hemp industries, and by the facility for importing Baltic and Belgian flax (for flax cultivation in Scotland has practically ceased), the linen industry has maintained itself to a far greater extent than in England.

Ireland.[1]—Of very early origin, the manufacture of linen in Ireland was for a long period given no encouragement as being prejudicial to the wool trade. It is thus of little moment until the seventeenth century, towards the end of which legislation laid for it a permanent foundation by prohibiting the export of wool from Ireland except to Britain (lest the cheap Irish labour should undercut England's wool trade in foreign markets), and by admitting Irish flax and linen into England free of duty. Its growth was materially aided, too, by the influx in 1685 of Huguenot refugees, who settled mainly in Protestant Ulster and in Dublin (those in Dublin being chiefly silk and poplin weavers); whilst the encouragement of flax-growing by Charles II, and the improvement of the methods of cultivation and bleaching by the Huguenots, were other contributory factors. As in Scotland, a Board of Trustees was established to assist the growing of flax and to preserve the quality of the produce by grading and marking all cloth; like the Scottish board, this continued in action for more than a century. The vast expansion of the trade during the eighteenth century[2] was achieved entirely without mechanical power, and until about 1830 the linen manufacture was a cottage industry; only in 1828 was the first flax-spinning machine erected in Belfast, and although power looms began to appear from 1850 onwards, hand-loom weavers remained an important section of the linen operatives until the 1914–18 war.

[1] See H. W. Ogden: "The geographical basis of the Irish Linen industry." *Journ. Manchester Geog. Soc.*, XLV, 1934–5, 41–56.

[2] Annual export 1700: about 2–300,000 yards. 1800: about 30–40 million yards.

Power machinery rendered certain the dominance of the Ulster region, by reason of its nearness to imported coal supplies and to the port of Belfast. Over the rest of Ireland production, except perhaps for home use, has practically ceased.

Processes in the Linen Industry.—Flax is by no means so simple a fibre to deal with as cotton, and it is very liable to be injured by careless treatment during the preparatory processes. The pulled flax must first be retted in water in order to remove soft tissues and gummy matter and to facilitate the separation of core and fibre. It is in this process that ignorance or carelessness on the part of the farmer may lead to much damage. The retted stalks are then scutched (beaten) to remove the woody core; the waste fibre produced thereby is called " tow " and is used for making twine and canvas. After scutching, about five per cent. by weight of the original flax plant remains. Before spinning, the fibre must be submitted to roughing and hackling processes—*i.e.* combing out short fibres (producing more " tow ") untangling and parallelising the fibres and then cutting out the middle (best) part of each length. The " line " (as distinct from " tow ") is combined by machinery into slivers, which are further drawn out in a drawing frame and wound on bobbins for spinning. In Scotland dry spinning is mostly practised—giving strong yarn for towelling and for weft in mixed goods. In Ireland, for finer and more even yarn, the rovings are passed through hot water before spinning. The spun yarn is doubled for use in the lace, tailoring, carpet and fishing-net trades; and yarn for fine linen goods is bleached and boiled before being woven. The weaving process needs no comment. To a greater extent than any other textile, linen derives benefit from bleaching. Grass bleaching is still done in Ireland, away from the smoky towns, but most of the linen is bleached and finished by chemical and mechanical methods.

The products of the linen industry are four in number: (1) *Yarn*; (2) *Brown cloth* (unbleached)—canvas, duck, and drills; (3) *Fully bleached*—for shirtings and sheets, damasks, and cambrics; (4) Articles made from fully bleached cloth—sheets, handkerchiefs, table-cloths, and so on, in immense variety, plain and embroidered.

Raw Materials.—The Irish flax crop being insufficient to supply the linen industry of Ulster and the Scottish crop being almost negligible, a considerable import of raw flax and spun yarn is necessary, as the tables on p. 510 show.

Before 1914 Russia supplied the bulk of the requirements, but between the Revolution and 1932 only a very small proportion came from the U.S.S.R. This proportion, however, has notably increased, and the U.S.S.R. is now the chief source, especially of raw flax and tow. The chief flax-growing area of old Russia lay in the north-west, and the new republic of Latvia and its neighbours

now contribute towards our imports. The other main source is Belgium, and the adjacent parts of France and Holland. From Belgium most of the imported yarn—mainly of coarser varieties in the production of which Ireland cannot economically compete—is derived. It is noteworthy, however, that between 1930 and 1936 there was a distinct drop in the amount of yarn imported, and a corresponding increase in the amount of tow, from which the coarser yarns are spun.

IMPORTS OF FLAX AND LINEN YARN
(Thousand Cwts.)

Variety of Product	1913	Average 1921–25	Average 1926–30	1931	1932	1933	1934	1935
Raw Flax . . .	1,686	564	708	579	617	560	756	679
Tow or Codilla . .	364	140	132	286	355	453	477	444
Flax Yarn . . .	248	89	143	138	80	37	46	20

PORTS IMPORTING FLAX AND LINEN YARN
(Thousand Cwts.)

Town	1913	Average 1927–30	1931	1932	1933	1934	1935
Belfast	1,363	492	696	775	762	831	681
Dundee	451	182	113	156	160	265	288
Leith	266	149	102	72	61	77	90
Aberdeen . . .	106	45	12	5	0·4	2	1
Glasgow	33	28	15	12	21	23	16
London	70	16	38	4	18	17	8

FLAX PRODUCTION OF NORTHERN IRELAND [1]
(Thousand cwts.)

1913	Average 1926–30	1931	1932	1933	1934
253	116	28	23	43	73

[1] International Yearbook of Agricultural Statistics—figures converted from quintals.

IMPORTS OF FLAX, TOW AND LINEN YARN BY COUNTRIES
(Thousand Cwts.)

Country	1913	Average 1921–25	Average 1926–30	1931	1932	1933	1934	1935
U.S.S.R.[1] .	1,583	74	34	120	396	482	633	458
Estonia . .	—	79	67	6	11	62	51	66
Latvia . .	—	168	319	442	305	119	98	168
Lithuania .	—	12	22	2	1	0·5	10	19
Netherlands .	33	40	46	17	20	44	50	64
Belgium . .	517	259	378	340	310	322	394	343
France . .	42	17	38	36	14	2	5	5

[1] Russia prior to 1921.

The Linen Industry To-day.—The United Kingdom possesses about one-third of the world's flax spindles, and Ulster is the greatest linen-manufacturing region of all. Belfast is the hub of that industrial area, and three-quarters of the mills are within 30 miles of the city. Belfast dominates the linen industry to an even greater extent than Manchester does the cotton industry, for it is the chief manufacturing centre as well as being commercial focus and port. Other important centres are Lurgan, Banbridge, Portadown, Ballymena, and Lisburn, but many of the small towns are associated in one way or another with the industry (cf. Chapter XXIX, p. 619 and Fig. 222). There is some separation of spinning and weaving, many firms confining themselves to one branch only, but the division is not so marked, either economically or geographically, as in the case of the Lancashire cotton industry. The Irish linen industry has suffered considerably from the competition of more cheaply produced yet artistically finished cotton goods, and from the decline in the demand for linen blouses and embroidered work; but much has been done since 1918[1] to improve the quality of the Ulster flax by scientific approach to the problems of cultivation and retting.

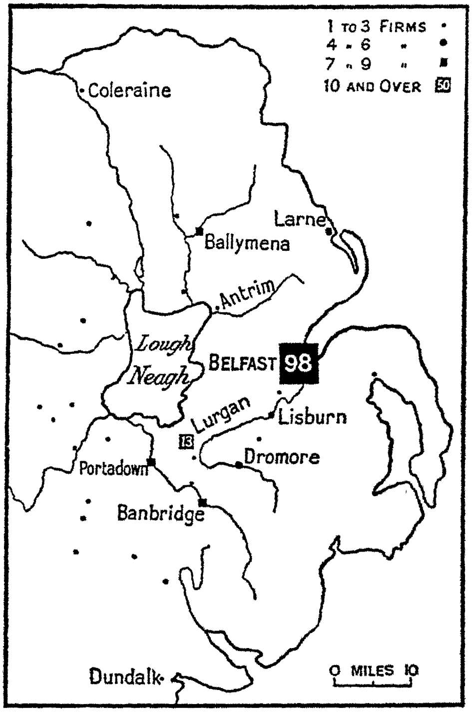


FIG. 222.—The Irish linen province.

Whereas Ireland has always been famous for its fine quality linen, eastern Scotland has for a long period been associated with the coarser types of product. This is partly, no doubt, due to the remarkable development of the manufacture of the coarser fibres, jute and hemp, in that region. Of a number of towns in the counties

[1] The "Linen Industry Research Association" was formed just after the war. It had Government backing and includes all the principal firms in its membership.

of Angus, Perth, and Fife, devoted to the linen industry, the chief are Kirkcaldy, Dunfermline (famous for its damasks), Dundee, Forfar, and Brechin. Most of the linen yarn is obtained from Belfast.

In England, Manchester is the only town having a linen industry of any considerable importance. Numerous other towns, however, use flax in combination with tow and hemp for the production of the coarser varieties of linen cloth.

Like the cotton trade, the linen industry depends primarily upon the export market. Only about 20 per cent. of its produce is retained in the United Kingdom. Unlike cotton, however, its chief market is North America. The United States has for many years taken over one-third of the total exports, and Canada has been second on the list.

EXPORT OF LINEN YARN AND MANUFACTURES [1] BY COUNTRIES
(Thousands of £'s)

Country	1913	Average 1921–25	Average 1926–30	1931	1932	1933	1934	1935
China	38	85	201	293	83	226	270	343
U.S.A.	3,962	5,906	3,639	2,496	2,392	2,447	2.140	2,142
Brazil	212	295	323	97	198	337	201	208
Argentina	334	340	264	91	72	87	120	134
South Africa	145	224	252	136	137	191	268	349
India	254	320	308	163	128	117	144	147
Canada	690	911	1,066	565	483	571	605	617
Other countries	3,829	4,359	4,124	2,084	2,301	2,499	3,003	3,252
Total	9,464	12,438	10,177	5,925	5,794	6,475	6,751	7,192

[1] Including hemp manufactures.

Belfast cannot afford to relax her grip on the foreign market, for formidable rivals in Belgium, France, Germany, and more recently Japan, are always ready to step in and seize the trade.

Hemp and Jute

The term hemp is applied very loosely to a number of fibres. Soft, or European, hemp is obtained from the stalk of the hemp plant, like flax, but large quantities of hard fibres, also known as hemp, are obtained from the leaves of sub-tropical or tropical plants —as manila hemp from the Philippines, phormium from New Zealand, sunn hemp from India, and sisal from West and East Africa and Mexico. The hemp fibres can be used for the coarser varieties of "linen," and in addition are much in demand for the manufacture of rope and twine, canvas, and sacking. All the hemp used in Britain has to be imported. The hemp-using industries are widespread, but tend to be concentrated (*a*) in the linen-manu-

facturing areas of north-eastern Ireland and eastern Scotland; (b) in the textile districts of south Lancashire and the West Riding, and (c) at the principal ports where there is a constant demand for rope and sacking.

Jute is a coarse fibre which will not bleach but dyes well, and although strong, perishes on exposure. It owes its lead among the minor textile fibres to its cheapness, which is due partly to the great production per acre and partly to the ease with which it can be

IMPORT OF RAW JUTE
(Thousand cwts.)

	1913	Average 1921–25	Average 1926–30	1931	1932	1933	1934	1935	1936
Total Import .	7,016	3,095	3,749	2,955	2,694	3,375	3,892	3,465	3,635
From India .	6,951	3,054	3,628	2,894	2,667	3,356	3,876	3,457	3,634

PORTS IMPORTING RAW JUTE
(Thousand cwts.)

Town	1913	1931	1932	1933	1934	1935
London	2,564	488	272	430	630	668
Dundee	4,350	2,424	2,392	2,826	3,206	2,742

EXPORT OF JUTE MANUFACTURES BY COUNTRIES (including yarn but excluding cordage, etc.)
(Thousands of £'s)

Country	1913	Average 1921–25	Average 1926–30	1931	1932	1933	1934	1935
Netherlands . . .	148	154	289	123	129	156	163	185
Belgium	104	72	174	44	46	56	87	100
U.S.A.	1,653	1,891	1,525	499	450	619	468	709
Brazil	299	322	388	214	152	131	92	127
Argentina	673	549	371	73	84	118	112	104
South Africa . . .	85	147	146	74	65	66	94	75
Canada	487	412	464	150	136	128	160	147
Other countries . .	1,890	1,964	2,001	1,059	910	937	1,162	1,207
Total . .	5,339	5,511	5,358	2,040	1,972	2,211	2,338	2,654

prepared, spun, and woven by modern methods. The jute industry in Britain grew out of the flax and hemp manufacture of the Dundee region, whither Indian jute began to make its way in the 'thirties of last century. Its progress at first was slow, owing to the difficulty

of manipulating the fibre and of adapting the flax machinery to its use, but in the 'fifties the industry became so profitable that most of the Dundee spinners and weavers changed over from flax to jute and the new fibre became the principal material for sackcloth and hessian, and was used with hemp to produce coarse sheeting. Another important use found for it was in the manufacture of carpets and linoleum; the town of Kirkcaldy has become the chief centre in Britain for floorcloth manufacture. A very large proportion of the jute industry is still centred at Dundee, very few other places, except one or two nearby towns (*e.g.* Tayport) and a few of the principal ports, having adopted it. The tables on p. 513 illustrate the jute trade.

Silk.—Judged by the length and fascination of its history,[1] the silk industry deserves a chapter to itself. Although a revival has taken place recently, collaterally with the extended use of artificial silk or rayon, the prosperous days of the industry were those of the eighteenth and early nineteenth centuries. Silk, like wool, has been worked by domestic labour in many parts of Britain (Fig. 223), but as its manufacture developed after that of wool the existence of wool-working centres tended to influence the siting of the early silk industry; and in subsequent periods other textile industries, such as hosiery, cotton, and the woollen industry of the post-machinery age, have exercised an attraction.

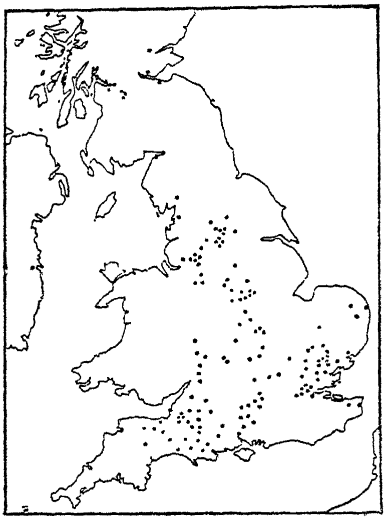


FIG. 223.—Map showing all localities where the silk industry has been carried on in Britain.

Notice the concentration in (1) London and the Eastern Counties; (2) the West Country; (3) the Midlands, including the West Pennines; (4) the Lancashire-Yorkshire textile regions and (5) the Scottish Lowlands.

Although earlier records exist, the real beginning of the silk industry dates from the sixteenth and seventeenth centuries when skilled Flemish and French craftsmen were seeking refuge in Britain from persecution on the Continent. In the sixteenth century Flemish weavers were making bombazines in Norwich and Colchester (early centres of the worsted industry), and numerous other towns, such as Sandwich (the port at which many of them landed),

[1] See Sir F. Warner: *Silk Industry of the United Kingdom* (1921)—very detailed.

Macclesfield, which began making silk buttons, Coventry, which made ribbons, and Canterbury, making fine gold silks, harboured the foreigners and their crafts. During the seventeenth century the development of the knitting frame encouraged the development of silk-hose manufacture at Nottingham and Derby. Then the influx of Huguenots, in and after 1685, brought further skill to Britain. A colony of considerable size was established at Spitalfields, in the east end of London,[1] and small bands of refugees settled in many likely and unlikely towns all over the country. By 1700, the silk industry, centred chiefly at Spitalfields, was one of Britain's most flourishing trades. Commencing in 1713, the government devoted considerable attention thereto[2] by placing heavy duties, and later total prohibition, upon imported silk goods, and the result was a considerable expansion of the manufacture in various parts of the country, raw silk being obtained from Turkey and the Levant, from Italy, and India. Physical influences in the location of the manufacture were almost non-existent; neither the raw material nor the finished product was bulky, and weaving might take place anywhere. The pre-existing woollen industry and the accidental settling of foreign craftsmen are all the explanation that can be given.[3] The introduction of the silk throwing process into this country from Italy by John Lombe in 1717 at Derby gave a new aspect to the industry. Derby and the Macclesfield area developed numerous mills, and the introduction of ribbed hose (cf. p. 504) gave a further fillip to the industry in Derby, where silk was the staple trade by 1800. Norwich reached the height of its prosperity between 1740 and 1760, its black crêpe and "challis" (a fine silk-worsted material) becoming standard materials for women's clothing. Several centres further south, *e.g.* Braintree and Bishop's Stortford, began silk throwing, and Spitalfields had 30,000 workers in 1800. Numerous West Country towns, already important for wool, also took up the trade, for example, Malmesbury, Sherborne, Taunton. Dublin had a flourishing silk industry in the late eighteenth century, developed by French immigrants, and at Paisley, where silk gauzes began to be made about 1760, no less than 10,000 people were employed in the 'eighties, before the coming of cotton almost ruined the trade.

The greatest period of the silk industry was the first half of the nineteenth century. The Spitalfields area declined rapidly after

[1] Spitalfields already had a wool-weaving industry, carried on mainly by Nonconformists—two very good reasons for the settling of the dissenters there. About 15,000 foreigners settled in London and its eastern suburbs in 1685–6.

[2] 1713–65, heavy duties; 1765–1826, total prohibition of manufactured silks; 1826–60, tariff of 15 per cent. *ad valorem*; 1860, abolition of all duty.

[3] In some cases water, in connection with dyeing, exercised some influence. For a detailed examination of geographical factors, see C. L. Mellowes: "The geographical basis of the West Pennine Silk Industry." *Journ. Textile Inst.*, Oct., 1934, 376–88.

the development of machinery, owing to its high labour costs compared with the provinces, but a considerable expansion took place in the Macclesfield area, and many more West Country towns took up throwing and weaving. The introduction of machinery for spinning "waste" silk (short fibres) brought two new areas into the industry, the West Riding, where spun silk began to be employed for admixture with alpaca and fine worsteds, and for making plushes and upholstery cloths, and South Lancashire, where cotton machinery was quickly adapted for silk—and still further increased the importance of the Cheshire centres.

A sudden blow was given to a large part of the silk industry in 1860 by the abolition of the duties, thus allowing cheap French silks to flood the English market. The 130,000 employees of 1851 were reduced to 39,000 in 1901, and at such important centres as Derby and Coventry, and in many West Country towns, the industry practically ceased to exist.

At the present time the principal silk-manufacturing region lies in south-east Cheshire and north-west Staffordshire, at Macclesfield, Leek, and Congleton. The water supply of the Pennine streams has been of considerable importance here in enabling fine dyeing and finishing to be done. A silk province of less rank is Yorkshire. Brighouse is the chief seat of silk spinning in the country, and numerous other wool-textile towns (*e.g.* Bradford, possessing the largest mills in Britain) have silk mills, producing plushes, upholstery cloths, and mixed fabrics. The rest of the silk industry comprises the scattered remnants of that which is indicated in Fig. 223. Norwich, Braintree, Sudbury, and Haverhill in East Anglia, Tiverton and Taunton in the west country, Nottingham and Derby in the knitwear province, Manchester, Glasgow, and Dublin (famed for poplins) are perhaps the most important. The following tables illustrate the silk trade. As in the case of the linen industry, there has been a notable recent increase in British spinning, as evidenced by the striking increase of raw silk imports (mainly from Japan) and the decline of yarn imports. The absence of a corresponding increase in the export trade is indicative of an expansion of the home market.

IMPORTS OF RAW AND SEMI-MANUFACTURED SILK
(Thousand lbs.)

Variety	1913	Average 1921–25	Average 1926–30	1931	1932	1933	1934	1935	1936
Raw Silk	970	717	1,290	1,875	2,352	2,820	3,633	4,133	4,288
Knubs and Waste	6,272	3,024	2,789 [1]	1,537	2,373	2,727	3,971	2,222	2,544
Noils	1,120	183							
Thrown Silk	479	45	798 [2]	952	472	261	203	204	162
Spun Silk Yarn	575	682							

[1] 1926 and after. "Cocoons and Waste of all kinds."
[2] 1926 and after. "Silk Yarn."

IMPORT OF RAW SILK BY COUNTRIES
(Thousand lbs.)

Country	1913	Average 1921–25	Average 1926–30	1931	1932	1933	1934	1935
China	508	312	369	320	206	280	239	285
Japan	102	104	526	1,208	1,782	2,201	2,924	3,549
Italy	58	177	206	205	211	179	214	161
France	194	13	60	40	21	10	30	60

EXPORT OF SILK AND MANUFACTURES THEREOF BY COUNTRIES
(Thousands of £'s)

Country	1913	Average 1921–25	Average 1926–30	1931	1932	1933	1934	1935
U.S.A.	413	223	247	59	42	59	70	91
Argentina	86	102	59	32	37	40	94	104
India	89	67	72	43	81	62	85	82
Australia	147	335	348	202	229	121	116	120
New Zealand	29	83	60	41	26	16	18	21
Canada	204	174	120	42	26	12	24	44
France	322	244	170	106	96	83	85	117
Germany	241	18	131	56	56	58	82	92
Other countries	627	883	895	456	430	405	504	441
Total	2,158	2,129	2,102	1,037	1,023	856	1,058	1,142

Artificial Silk or Rayon.—The artificial silk industry is really a product of the twentieth century, for although much of the experimental work was accomplished between 1850 and 1900, it is really only within the last two decades that rayon has become a textile material of serious importance. The manufacture of rayon forms an interesting link between the textile and the chemical trades, and the principles of its production are dealt with in Chapter XXIII.[1] Moreover, its raw materials consist of wood pulp or short-staple cotton, so that adequate transport facilities are essential, and its processes consume enormous quantities of water.[2] Its localisation has thus been determined primarily by the pre-existing textile industries which we have described, cotton, wool, silk, and knitwear. Many old firms in south Lancashire and the Macclesfield area—both well placed as regards import of wood pulp, supply of cotton, chemicals, and water—and in the West Riding, have taken up the new industry, and in addition to pure rayon many new varieties of mixed fabrics—rayon mixed with cotton, wool, worsted, or spun silk—are being produced, Manchester, Stockport, Bolton, Rochdale, Bradford, Halifax, Keighley, Huddersfield, Macclesfield and Leek may be cited as examples, but the list is increasing.

[1] See *Artificial Silk Handbook* (published by the *Silk Journal*) for history and methods of production.

[2] Several million gallons per day are needed by a large factory such as those at Preston and Doncaster.

CHAPTER XXIII

THE CHEMICAL INDUSTRIES

LORD McGOWAN, the Chairman of Imperial Chemical Industries, Ltd., has aptly described the chemical industry as the most polygamous of all industries. There are few manufacturing industries to-day which can dispense with the services of the chemist, and the vast field covered by the chemical industry of to-day is the natural result of co-operation between the chemist and his fellow scientists, or between the chemist and the engineer and manufacturer. Quite truthfully the chemical industry has become the foundation on which not only British industry as a whole but also modern world-industry is erected. Not only has chemistry become the servant of the older industries but in many cases the powerful rival, and in some cases the master. The synthetic products produced by the combined ingenuity of engineer and chemist not only serve to meet demands created by a high standard of living, but come definitely into competition with substances of natural origin, or even the earlier products of the chemists themselves. Thus, synthetic nitrates are more than adequate competitors for the favours of the agriculturalist requiring nitrates for fertilising. The quantity of artificial silk used in the world probably now exceeds the quantity of natural silk. The last two or three years have seen chromium plating replace nickel plating just as nickel plated goods replaced brass and bronze of earlier periods. In the near future oil produced by the hydrogenation of coal will quite probably replace natural mineral oil when supplies of the latter begin to diminish. Synthetic sugar has now been produced by the chemist in the laboratory, and its manufacture on a commercial scale is only a matter of economic necessity or future demand.

The Heavy Chemical Industry

The heavy chemical industry is in many respects the chemical industry proper, and embraces the manufacture of those commodities which are required in large quantity and have a variety of uses. The birth of the whole chemical industry took place scarcely more than 200 years ago, and indeed, at the close of the eighteenth century there was scarcely a chemical industry in this or any other country —apart from the manufacture of gunpowder, a few acids in small

quantities, and a few drugs. One of the first chemicals produced in quantity was sulphuric acid, manufactured in England as early as 1720. The discovery of the value of chlorine as a bleaching agent in 1785 opened up a new avenue of manufacture, and towards the close of the eighteenth century the discovery of bleaching powder, or chloride of lime, by Charles Tennant, led in 1797 to the foundation of the chemical works at St. Rollox in Glasgow. Within a few years the manufacture of bleaching powder by passing chlorine over dried powdered lime was an important industry in many parts of the country. In 1790 the French Government awarded a prize to Nicholas Leblanc for a method of making soda, since France, owing to wars, had found it difficult to obtain a constant supply of this commodity. His method consisted of treating common salt with sulphuric acid, thus making sodium sulphate and liberating hydrochloric acid gas, then roasting the sodium sulphate with limestone and charcoal or coal and obtaining in this way sodium carbonate and calcium sulphide. The growth of the Leblanc soda process in this country was slow, but it is not difficult to see that salt is the primary raw material in the manufacture of soda and alkalis. Thus, the manufacture of soda, sooner or later, gravitated to the one great salt field of this country then known—the Cheshire salt field. It was not long before the factory of a soda manufacturer tended to become larger and more complicated. He not only made soda, using common salt, sulphuric acid, and other raw materials, but he started to make his own sulphuric acid by burning sulphur or pyrites. He produced large quantities of hydrochloric acid which at first were allowed to escape into the atmosphere with terrible results on areas around the chemical works. So it is easy to see how he became a manufacturer of acids, more especially of nitric acid, which is required in the manufacture of sulphuric. Then followed the various salts of sodium, copper, and iron. It was again a common development to use the chlorine recovered to make bleaching powder, and more and more efforts were made to utilise what had at first been waste products. Thus, at first, for every ton of soda made nearly two tons of alkaline waste were produced, an evil-smelling mass containing practically all the sulphur from the sulphuric acid used; and, although by a process introduced in 1861 a third of the sulphur was recovered, it was not until 1882 that waste was really eliminated. The elimination of waste was more or less forced on the chemical manufacturers by the Alkaline Act of 1863, which provided for close inspection, and for heavy penalties against emitting obnoxious fumes into the atmosphere. By 1890 the British heavy chemical industry was thus in the hands of forty or fifty firms whose works were situated principally on the salt-field of Cheshire and the neighbouring parts of the mid-Mersey region of Lancashire. As soda manufacturers they were suffering from the

severe competition of what is known as the ammonia-soda process for the manufacture of soda. Although the chemistry of the process involved in the mixing of salt, ammonia, carbon dioxide, and water, and having formed as a result bicarbonate of soda and ammonium chloride is very simple,[1] it was not until 1856–66 that the Solvays of Belgium were successful in producing soda in quantity by this process. It was they who, in 1873, granted a licence to Brunner, Mond & Co., a combination of Brunner the administrator and Mond the energetic young chemist, to manufacture in Great Britain. In 1890 the British heavy chemical firms were forced into combination and formed the United Alkali Co. of Liverpool. Although the object of the combination was to facilitate, by lowering costs, the continuance of the manufacture of soda by the Leblanc process, they were forced in turn to take up the ammonia-soda process. Some idea of the progress may be judged by saying that in 1863 the world's production of soda was 300,000 tons and the price about £13 per ton. In 1902 out of an annual production of 1,800,000 tons, 1,650,000 were made by the Solvay process, and the selling price was only about £4 per ton.

To go back somewhat, the close connection between the heavy chemical industry and many other industries was apparent early. With the Industrial Revolution the growth of the textile industry meant an increase in demand for acids, alkalis, soaps, and chemicals of all kinds. The increased use of soap all over the world meant increased demand for the alkalis used in its manufacture. Thus, there was a dual marriage of the chemical and the textile industries, the chemical and the soap-making industries. The ramifications of the chemical industry became increasingly apparent towards the latter half of the nineteenth century. The year 1887 saw the patenting of the famous McIver-Forrest Cyanide process for extracting gold and silver from refractory ores and from "tailings" —a process which has revolutionised gold mining, for there are few mines existing to-day which can be operated properly without a cyanide annexe to the mill. This has meant the extensive manufacture of cyanide in this country. Then the early experiments of Mr. J. B. Lawes, who succeeded to the Rothamsted estate in Hertfordshire, led to the appreciation of various artificial manures, and in 1843 Mr. Lawes established large works in the neighbourhood of London for the manufacture of the superphosphate of lime.

The outbreak of war in 1914 found the chemical manufacturers of this country somewhat ill prepared. There were government factories well equipped for the manufacture of explosives, but they were only on a small scale. Firms, such as Messrs. Nobel, had up-to-date works, but again on a small scale. Apart from some of the larger firms such as Brunner, Mond & Co. the smaller alkali

[1] $2NaCl+2NH_3+CO_2+H_2O=Na_2CO_3+2NH_4Cl$.

manufacturers had works which were far from up-to-date. At the beginning of the war most of our shells were filled with picric acid as an explosive, for T.N.T. or trinitrotoluene had only just been adopted. The first government factory for its manufacture was not commenced until February, 1915, although exactly three months later the first ton of T.N.T. was produced and packed for delivery and the factory was very soon producing to capacity. Of necessity the explosive firms in particular and the chemical firms in general had during the war period to work together and to pool their knowledge. The way was thus paved for the formation of the combine in November, 1918, of Explosive Trades, Ltd., afterwards known as Nobel Industries, Ltd. There thus came to be four great firms concerned with the chemical industries of this country:

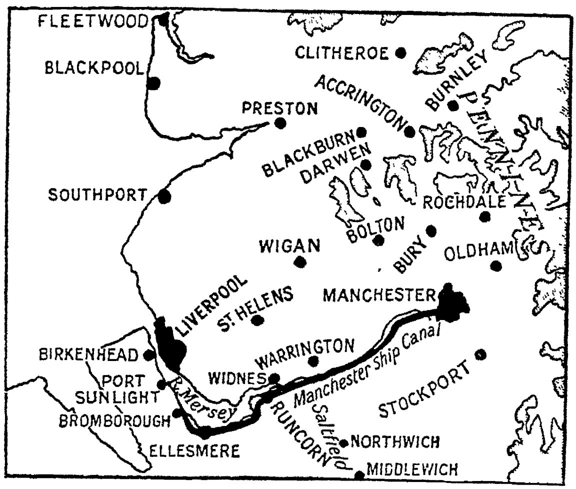


FIG. 224.—Map showing the relationship of the Cheshire salt-field to the Manchester Ship Canal and the chemical manufacturing towns.

Brunner, Mond & Co., Nobel Industries, Ltd., the United Alkali Co., and British Dyestuffs Corporation, Ltd. The amalgamation of these came naturally in 1926 with the formation of Imperial Chemical Industries, Ltd., the British combine with a capital of £65,000,000 sterling. If one studies the geographical distribution of the factories controlled by this corporation one is struck by the continued importance of some of the earliest factors. There is, in the first place, the concentration on the Cheshire salt-field, enormously strengthened by the construction of the Manchester Ship Canal, so that the principal works of the United Alkali Co. are at Widnes and Runcorn. Here, too, was the advantage of proximity to the centres of the textile trade as well as to the largest importing port of England, Liverpool, whence arrive the fats required by the soap

and margarine industries. Then practically all the works of Imperial Chemical Industries are accessible by water. Thus, there are the ammonia soda works at Fleetwood, and the works on the Tyne, the Thames, the Severn, and the Clyde. Then there is the old-established connection with an important group of consumers in the metallurgical trades, and hence an association particularly with the Birmingham district. This connection was particularly close in the case of the firms which later constituted Nobel Industries, Ltd. The manufacture of military and sporting ammunition involves the manufacture and use of copper, brass, and other metal compounds, and hence the association with the firm of McGuire Rodd, and in general with the great Birmingham trade in brass and metal supplies of all kinds. The associates of Brunner, Mond & Co. had already been influenced by similar factors. The earliest works were started in 1874—the Winnington works near Northwich on the Cheshire salt-field. Then came associations with firms near Runcorn, at Oldbury in the Birmingham area, at Middlewich on the salt-field again, and with producers of lime at Buxton (Derbyshire). In some areas, as for example on the Tyne,[1] there was the attraction of the availability of waste gases and cheap fuel. The general advantages of the Teesmouth area, stressed in another chapter, and the recent discovery and development of the great salt-field there rendered the area a particularly suitable one for the huge Billingham factory of Imperial Chemical Industries and the adjoining area of Haverton Hill. Finally, a new factor has come into operation in comparatively recent years, and that is the advantage of the tremendously high temperatures possible in the electric furnace and the advantages of developing hydro-electric power. Hence, the establishments at Kinlochleven, Foyers, and, lastly, near Fort William in Scotland.[2]

The Metallurgical Industry

This has been considered in part in the chapter on non-ferrous metals, but it needs to be mentioned here because of the enormous importance of chemicals in the industry, particularly of recent years, and hence the close association of the two. Thus, it was Mond of Brunner, Mond & Co. who discovered with a collaborator a process for the extraction of pure nickel from the ores and floated the Mond Nickel Co. The Mond nickel works at Clydach (Swansea) employ about a thousand men and have a capacity of 10,000 to 12,000 tons

[1] Mention might be made of the old Tyneside salt industry which was effectively stifled by the opening of the Mersey and Weaver Navigation in Cheshire.

[2] Great explosives works are often located in remote areas where wide expanses of poor land are available—especially stretches of sandy foreshore (as, for example, the works at Ardeer in Ayrshire, begun in 1873) where individual filling sheds are partly excavated in sand and are in small units so that an explosion in one would cause only limited damage. Many such establishments were started during the 1914–18 war and later abandoned.

of nickel a year. It is impossible here even to mention the numerous contracts between the chemical and metallurgical industries of similar character and which are of increasing importance year by year. Excellent examples are afforded by the development of tungsten, molybdenum, tantalum, and other metals in the electrical industries and the almost innumerable steel alloys which have different and distinctive properties.

The Gas and Coke Industries

Although the distillation of coal on a large scale for the production of gas seems to have been practised well before the end of the eighteenth century, and in Germany various experimenters had known the importance of coal gas as an illuminant, it was left to two men, Murdock of Ayrshire, and Lebonne a Frenchman, independently to develop the commercial production of coal gas for lighting purposes. Murdock lighted a large mill at Manchester in 1805 with gas, and in the meantime Winzau, a German who had failed to arouse enthusiasm in his own country, succeeded in doing so in London, and obtained sufficient money to carry out the lighting of the greater part of Pall Mall (January, 1807), the first public thoroughfare in the world to be illuminated by gas. His company received a royal charter in 1812, and is now the Gas, Light, and Coke Company. The gas industry made steady progress. The purification of the gas is now so good that further improvement cannot be regarded as really necessary. But up to 1890 the lighting properties of the gas depended upon those vapours it contained which burnt with a luminous flame; but later it was discovered that it was better and cheaper to remove from the coal gas these luminous gases and to rely on the heating properties of the gas to raise metallic oxides on gas mantles to so high a temperature that they became incandescent. So the problem became to maintain the heating properties of the gas at a maximum and to recover from the gas the vapours which had previously given luminosity to the flame. Gas is produced by heating bituminous coal in closed vessels called retorts. The volatile gas is removed and the porous coke, which remains, contains as high a proportion of carbon as anthracite and is used for similar purposes, especially for central heating. Gas, by reason of its nature, must almost of necessity be produced near centres of consumption, and the main geographical factor arising in the location of gasworks is the ease of import of the bulky raw material, coal. Hence the larger works, for example in London, tend to be riverside works. In the smaller towns the gasworks are almost invariably situated conveniently near the railway.[1]

Metallurgical Coke

Gasworks coke is far too soft and frangible to withstand the heavy burden of ore in a blast-furnace, and a special hard coke for iron-smelting is made in ovens from crushed coal of certain qualities (one of the main requirements being freedom from sulphur). Darby first made smelting coke from lump coal in open heaps at Coalbrookdale early in the eighteenth century, and this method was the standard practice in the Black Country and in South Wales for a long period. "Beehive" ovens, using small coal, were developed mainly in Durham, where the industry attained a phenomenal development during the second half of the nineteenth century, mainly owing to the growth of the smelting industry at Middlesbrough. The industrial depression in the last

[1] In 1934 a quarter of a million people were employed in the gas industry which uses 20,000,000 tons of coal annually with an out-turn of coke of 11,400,000 tons (1933) compared with 8,800,000 tons from coke ovens.

decades of the century, and the superb qualities of our fuel, especially in Durham, delayed the introduction into Britain of by-product recovery ovens, which were developed mainly in Germany. In 1907 less than one-fifth of our coke-ovens were equipped for recovering the valuable tar, benzine, ammonia and other products which can be distilled from the gases evolved during the coking process. Since 1918 there has been an enormous swing-over to by-product recovery ovens, and only an infinitesimal amount of metallurgical coke is now produced by any other means.

Only a few of our coalfields and coal seams yield coal of suitable quality —though with the development of scientific blending the range is increasing— and in consequence the coke industry is located in three main areas only, in south Durham, in south Yorkshire and north-east Derbyshire, and in eastern South Wales. In addition to these pit-head coking plants, however, vast quantities of coke are now made at the ironworks themselves, as at Middlesbrough, Scunthorpe, Corby, Cardiff, Dagenham, etc., for coke is more difficult to transport than coal, owing to its frangibility, and the "waste" gases from the ovens can be used for various power-producing purposes as well as for their by-products (cf. p. 369). In those areas where coke is made the gas is frequently used to supplement the gasworks' output for domestic and industrial use. The Sheffield area actually has a "gas-grid" on the same general principle as the electricity "grid."

The Dyestuff Industry

The aniline-dye industry originated in England in 1856 when a brilliant young chemist, W. H. Perkin, discovered that mauve could be manufactured from what, until almost that time, had been a plentiful raw material regarded as waste from the coal-gas industry; that is, from coal tar. Perkin and a band of young German chemists working in this country developed the industry, and for some years it flourished. But the nation did not appreciate the brilliant discoveries, and the whole industry practically disappeared from Britain and was built up on a commercial scale in Germany. There it became one of enormous importance, and the artificial dyes made from coal tar practically eliminated from the world's markets natural dyes such as indigo. The outbreak of war in 1914 found this country almost totally unprepared so far as a supply of dyestuffs was concerned. But two firms were still in existence and they were galvanised into immediate action; for it has been truthfully said that without dyestuffs an army cannot be uniformly clothed, and an army without a uniform is but a rabble. A new firm started work at Manchester and Scottish Dyes, Ltd., at Grangemouth in Scotland. Amazing progress was made, so that by 1918 it was not surprising to find an amalgamation of interests under the name of British Dyestuffs Corporation, Ltd., which later purchased a controlling interest in Scottish Dyes. In turn, as part of the chemical industry, this became an essential constituent of Imperial Chemical Industries, Ltd., and British dyestuffs can claim to be unrivalled in the world. About 80 per cent. of dyes used in Britain are now home-produced.

Artificial Silk Industry

There is an unexpectedly close connection between explosives and artificial silk, both being closely connected with cellulose, which is the main constituent of dry vegetable matter, and thus forms the bulk of wood, cotton, linen, and many other vegetable products. Thus, if cotton rags are treated with caustic soda, washed, bleached, and dried the production of cellulose is the result. If the cellulose is dissolved in a mixture of sulphuric and nitric acid nitro-celluloses are formed which are in general highly inflammable or explosive substances. Gun cotton is a nitro-cellulose, and cordite and other explosives are closely associated; while T.N.T. (tri-nitro-toluene) is the explosive which attained such marked importance during 1914–18. On the other hand harmless solids can be formed from similar bases. Examples are xylonite—a mixture of nitro-cellulose and camphor with a little castor oil, and celluloid which is a mixture of nitro-cellulose and camphor. The principle of making artificial silk is to dissolve nitro-cellulose in some liquid and then to squeeze the liquid through very tiny holes so as to make a thread which, when it is dry, is as fine or almost as fine as the silken thread naturally spun by the silkworm. As early as 1885 a few articles were exhibited at the inventions exhibition under the description of artificial silk; but the real progress of the industry is very largely post-1918. Three-quarters of the world's output of artificial silk is now viscose silk. Broadly, in its production, wood pulp or some other material containing cellulose is treated with caustic soda and then with carbon bisulphide; a yellow viscous liquid being obtained which when put into a suitable precipitating bath yields tough fibres. A further process is used to remove the sulphur from such fibres. Another variety of artificial silk is acetate silk, and in either case it will be seen that large quantities of chemicals enter into the new industry, but there follows the subsequent spinning and weaving; so that it is largely the older spinning and weaving firms and the older spinning and weaving centres which have taken up the new manufacturing process (see Chapter XXII).

The Soap Industry

Although the making of soap is essentially a chemical industry, soap making long ante-dates the development of the chemical industry properly speaking. The art of boiling together oils and fats with an alkali (which was usually obtained by burning seaweed, thus giving an impure alkali containing both soda and potash), and then adding common salt which throws out the soap into a curd that can be cut into bars, tablets, and the like was practised long ago. But clearly the modern connection with the chemical industry is the large requirement of alkali. In the early days almost

any fat or oil was used, and it is not surprising therefore to find the early soap-boiling works scattered in different places throughout the country. The great firm of Levers, with its £70,000,000 of capital, and its turnover in an average trading year of £80,000,000 sterling, has been built up very largely on the utilisation of vegetable oils instead of animal fats as the basis for soap making. The greatest of all the centres created by the company, Port Sunlight, was initiated by the cutting of the first sod in 1888. Considerations which are said to have led W. H. Lever to select this site were that it was a rural area where ample acreage could be secured adjacent to both rail and water transport with reasonable facilities for obtaining the necessary supply of labour. Incidentally the area chosen is conveniently situated in a remarkable way to the alkali-manufacturing centres of the Mersey. The Lever interests gradually absorbed many of the soap-making companies ; there was close connection also with those who were using oil for other purposes, such as the British oil cake mills, and finally, in 1929, came the merging of interests with the Margarine Union which had been using vegetable oil for the manufacture of margarine. The whole great combine is known as Unilever, Ltd.

Other Chemical Industries

The manufacture and supply of alcohol for industrial purposes and the connection of the chemical industry with brewing and distilling should be noted. Then there is the manufacture and supply of chemicals as drugs, the huge consumption of which can be gauged by the large number of chemists shops now found throughout the country. In Britain this industry is particularly associated with the firm of Boots at Nottingham. The manufacture of matches and vestas is coupled with the name of Bryant and May—the largest British manufacturers—in east London. The important paint and varnish industry is generally tributary to the centres of heavy chemical manufactures, notably the north-east coast where it grew up in association with lead manufacture and shipbuilding. Some idea of the importance which may still lie before this industry may be gauged from the estimation of Sir Robert Hadfield, that the corrosion of iron and steel is estimated to cause a loss of £650,000,000 sterling per annum throughout the world, and much of this loss is preventable by the adoption of protective measures of which painting is an important one. Connected with the paint and varnish industry is the linoleum industry. Oxidised linseed oil and cork are mixed with gum or resin and with pigments, and pressed out on a rough canvas body between steam-heated rollers. Kirkcaldy (Fifeshire) has remained the seat of manufacture in this country. The essential process in the manufacture of paper is the treatment of wood pulp with either soda or with the sulphite of

calcium or sulphite of magnesium, the wood pulp being bleached by calcium hypochlorite, and the paper being loaded with some white substance such as china clay or calcium phosphate so as to fill up the pores and make it suitable for printing purposes. Then the manufacture of glass is essentially a chemical process. All types of glass are made by heating in a furnace, silica (which is usually obtained in the form of sand) with soda or potash or some other oxide, or sometimes mixture of oxides—of soda, potash, lead, calcium, barium, or bone. Plate glass is rolled in continuous sheets while soft. Glass tubing is drawn out. Glass bottles are usually cast in moulds. Thus the two great requirements of the glass-making industry are obviously a suitable supply of sand, and the chemicals from the heavy chemical industry, notably soda or potash. For the finer types of glass, such as optical glass, the utmost care is necessary in selecting the sand; but for ordinary bottle glass a very considerable variety of sand can be used, and hence supplies are available in many parts of the country. It is not surprising to find the glass bottle-making industry, therefore, centred at St. Helens in Lancashire (where are the works of the famous firm of Pilkington Brothers, Ltd.) quite close to the Cheshire salt-field and the associated chemical industrial regions.

Of extraordinary interest is the recent rise of the plastics industry which, although it was in existence before the 1914–18 war, is essentially a product of the last two decades. The stimulation of chemical research during the war paved the way for the technical advancement of the industry, and the huge development of the radio, motor-car, aircraft, electrical and domestic building industries provided an enormous market for useful and ornamental mouldings ("Bakelite" etc.) and insulators. The industry is dependent on a great variety of raw materials, amongst which the following may be noted: (a) *mainly imported*:—resin (from coniferous trees, U.S.A., etc.), shellac (lac from India), bitumen (Trinidad), cotton linters (U.S.A., etc.), wood pulp (Canada, Sweden), acetylene (calcium carbide produced in Canada, Norway, etc., by hydro-electric power), casein (from skimmed milk, Denmark, etc.): (b) *produced in Britain*:—phenol (from coal tar), formaldehyde (from carbon monoxide and hydrogen), urea (from ammonia and carbon dioxide), alkyds (from glycerine and phthalic acid, a gasworks product). The location factors in the industry are thus those of market and labour supply, and it is not surprising that the chief firms in the industry are located in the London and Birmingham areas.

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CHAPTER XXIV

MISCELLANEOUS MANUFACTURES

In the preceding chapters we have dealt in turn with the major industries of Britain. It is true that we still have some miscellaneous manufacturing industries to consider but, even allowing for these, there remains the remarkable fact that well over half the population of these islands has still to be accounted for. It is worth while to study with some care the tables which follow in that they illustrate the relative importance of the occupations not yet considered.

CENSUS OF 1921 AND CENSUS OF 1931

The Manufacturing Industries

Occupation: workers in	Number per 1,000 occupied—England and Wales		Number per 1,000 occupied—Scotland	
	Men	Women	Men	Women
Brick-making, pottery, and earthenware	7 (9)	8 (9)	1 (2)	—
Glass and glassware	3 (3)	1 (1)	1 (1)	—
Chemical industries	12 (12)	10 (9)	3 (3)	—
Metals	157 (140)	44 (49)	182 (182)	10 (10)
Metals (precious)	4 (3)	5 (3)	1 (1)	0 (0)
Electrical	10 (15)	8 (12)	11 (10)	1 (1)
Leather	3 (3)	2 (2)	1 (1)	2 (2) (Leather and Leather-goods)
Leather-goods	2 (1·5)	2 (3)	1 (2)	
Textiles	40 (37)	129 (121)	18 (17)	124 (120)
Textile goods and dress	26 (24)	99 (94)	14 (17)	59 (84)
Food	19 (21)	29 (31)	16 (16)	26 (28) (Food, Drinks and Tobacco)
Drinks	1 (1)	4 (4)	2 (2)	
Tobacco	1 (1)	6 (6)	0 (0)	
Wood and Furniture	17 (20)	5 (6)	40 (47)	3 (2)
Paper making	3 (3)	2 (2)	4 (3)	15 (13)
Printing and Photography	15 (18)	21 (23)	8 (8)	9 (8)
Building, painting, and decorating	62 (78)	2 (2)	56 (54)	0 (0)
Gas, water, and electricity	13 (17)	1 (1)	—	—

Figures in brackets are those for 1931.

CENSUS OF 1921 AND CENSUS OF 1931

Area	Total population	Men	Men "gainfully occupied"	Women	Women "gainfully occupied"
England and Wales (1921)	37,886,699	18,075,239	12,112,718 (67 per cent.)	19,811,460	5,065,332 (26 per cent.)
England and Wales (1931)	39,952,377	19,133,010	13,247,333 (69 per cent.)	20,819,367	5,606,043 (27 per cent.)
Scotland (1921)	4,882,497	2,347,642	1,543,177 (66 per cent.)	2,534,855	636,092 (25 per cent.)
Scotland (1931)	4,842,980	2,325,523	1,542,253 (67 per cent.)	2,517,457	659,057 (26 per cent.)

Approximately 87 per cent. of the males *over* 12 *years of age* were occupied and 32 per cent. of the females. This table *excludes* unemployed.

CENSUS OF 1931 (ENGLAND AND WALES)
Industrial Distribution of the Occupied Population

		Males		Females	
		No.	Per 1,000 occupied	No.	Per 1,000 occupied
I.	Fishing	26,945	2	80	0
II.	Agriculture	1,116,573	84	55,683	10
III.	Mining and Quarrying	966,210	73	2,561	0
IV–XXI.	Manufacturing (including building)	—	323	—	281
XXII.	Transport and communication	1,565,846	118	68,899	12
XXIII.	Commerce and finance	1,466,587	110	604,833	109
XXIV.	Public administration and defence	290,202	22	2,906	1
XXV.	Professions	356,726	27	389,359	69
XXVI.	Entertainments and sport	91,654	7	22,369	4
XXVII.	Personal service	462,935	35	1,926,978	345
XXVIII.	Clerks, draughtsmen, typists	795,486	60	579,945	103
		13,247,333	1,000	5,606,043	1,000

These figures may be compared with 1921 when 39 per cent. of the working population were engaged in manufactures.
13 per cent. in wholesale and retail trade, commerce, and finance.
12 per cent. in personal service, including hotels and restaurants.

The Manufacture of China, Pottery, and Earthenware

According to the census of 1921, no less than 72 per cent. of all the male workers in England and Wales in this industry were in Staffordshire, and of females the proportion was nearly 80—66 per cent. in Stoke County Borough alone. This illustrates the remarkable concentration of the industry in the North Staffordshire coalfield. The only other areas of importance are Derby (employing 6 per cent. of the men) and London.

The North Staffordshire coalfield has become so identified with the pottery industry that the region itself is known all over the world as "The Potteries." Yet pottery making is not the only industry, nor indeed is it the earliest with which the region was associated. The triangular-shaped area of the coalfield lies in the south-western corner of the Pennines. It is in this area that a number of southward-flowing streams unite to form the headwaters of the Trent which, after a southward course, flows round the southern end of the Pennines and then northwards. A low divide, not much more than 500 feet in height, separates the headwaters of these streams from the Cheshire Plain; whilst to the north-east lie the lofty Millstone Grit highlands of the Pennines. Thus the North Staffordshire coalfield is a region curiously isolated by nature, and though there are records of early coal mining the coal was only used locally. There are certain difficulties in explaining why the pottery industry should have become concentrated in this region. There seem to be no records of pottery works before the seventeenth century. In the Middle Ages the making of rough earthenware pots was a typical domestic industry widespread over the countryside; in fact carried out wherever there was clay together with wood for firing. In the seventeenth century coal replaced wood for firing, but on practically all the coalfields there are belts of clay suitable for rough pottery manufacture. It would seem that the industry was favoured in the North Staffordshire coalfields because of its isolation, and the comparative poverty of the region agriculturally. The agricultural land was in the main occupied by smallholders, and the industry grew up as a side line to agriculture. Pots were made in a shed at the side of the dwelling-house or the cowshed. The men dug their own clay, often in their own garden, and at least some of the families dug the coal with which to fire the ovens. Lead for powder glazing was obtainable from the Carboniferous Limestone of the Derbyshire Dome. And thus there grew up amongst the agricultural population a large number of skilled master potters, amongst whom were men of brain and foresight—particularly, of course, the famous Wedgwood family.[1] Amongst the improvements invented was that of salt glazing, the use of moulds, whilst greater care was exercised in selecting the clays used

[1] Especially Josiah Wedgwood (1730–95) who commenced manufacturing at Etruria, near Stoke-on-Trent, in the 1760's.

and studying their colour and consistency. By the middle of the eighteenth century the industry was already such an important one that special clays from Dorset and Devon were imported, together with flints; in addition to the firebricks, heavy earthenware, and other coarse ware made from the local marls, the district had become noted for its chinaware, especially after the importation from Cornwall of china clay, which commenced in 1770. 1770 was an important year for the industry, for it was then that, after much agitation for its construction, the Trent and Mersey Canal was opened. Previously, although great quantities of flint stones used in making some of the ware were brought by sea from various parts of the coast to Liverpool and Hull, it was still a long and difficult overland journey to the Potteries. The opening of the canal meant direct water connection between Cornwall and Staffordshire. It seems curious that practically all the china clay from the south-west (excluding that exported) should find its way to the Staffordshire coalfield, but one must remember that there is no coalfield near the Cornish deposits which are themselves conveniently situated to the coast of Cornwall for ready export of the raw material. The Mersey-Trent Canal left the Mersey in the neighbourhood of Runcorn where it connected with the Bridgewater Canal—the precursor of the Manchester Ship Canal. But the canal had to pass through the western hill barrier of the Potteries by the Harecastle tunnel, and in its course of 93 miles there are 75 locks. From the Potteries there is navigable water all the way to Hull. So the connections were established between the Potteries with Hull on the one hand and Liverpool on the other. However, the canal remains of importance even to the present day. Thus, the industry has continued and developed, although only the coal is really obtained locally.[1] The old market centre of the agricultural region was the town of Newcastle—Newcastle-under-Lyme or Newcastle-under-the-shadow-of-the-Pennines. It has not become one of the pottery towns but is a non-industrial residential town. The pottery towns themselves spread out in lines following certain of the bands of clay most utilised. The chief centres were Stoke, Burslem, Hanley, Tunstall, Longton, and Fenton which, after considerable negotiation, were united in 1909 as the county borough of Stoke-on-Trent with the status of a city (1925) and a population of nearly 300,000 persons. Here the pottery industry employs over 35 per cent. of the total working population. Altogether there are over 300 pottery works, and these have naturally attracted various connected industries such, for example, as those connected with the manufacture of the necessary machinery, the manufacture of brushes, chemicals, colours, glazes, and stains. The "sanitary ware" industry is often based on Coal Measure shales, *e.g.* Kilmarnock and Barrhead.

[1] Requirements obtained from elsewhere include china clay from Cornwall, ball clay from Dorset, flints from Normandy and elsewhere, felspar from Derbyshire and Norway, bones from the great cattle rearing countries such as Argentina.

The Supply of Electricity

In the Census returns electrical apparatus makers, electricians, and electrical engineers are included together. The manufacture of electrical machinery and apparatus has already been considered in Chapter XXVIII, but it will be useful here to deal with the supply of electricity.

Until 1926 the systems of supply of electricity in this country were the result of unplanned growth. Local legislation and piecemeal development had resulted in the existence of numerous isolated area supplies with a great variety of generating plant, frequencies, and pressures. Two inevitable consequences followed —an almost incredibly wide variation in the cost to the consumer of a unit of electricity and a paralysing or stultifying effect in large scale developments. The domestic consumer might have been called upon to pay anything from ½*d.* or even less per unit to 1*s.* per unit—occasionally more. This book was written in the London School of Economics which, owing to rapid growth, came to include buildings adjacent, but supplied with electricity from two sources. Thus, in some rooms the voltage was 100, in others 210; in some it was direct current, in others alternating! The Electricity Supply Act of 1926 provided for the setting up of a Central Electricity Board. Within this new national scheme electricity is to be generated only at those stations where generation can be most economically carried out. These "selected stations" remain the property of the municipal corporations or companies who own them, but the national network of transmission lines connecting them is the property of the Central Board. This network of lines for the transmission of energy at high tension (commonly known as the Grid) has rapidly become familiar through the erection of pylons in all parts of the country, and over these lines takes place the "wholesale" transmission of the current to the various local distributing undertakings.

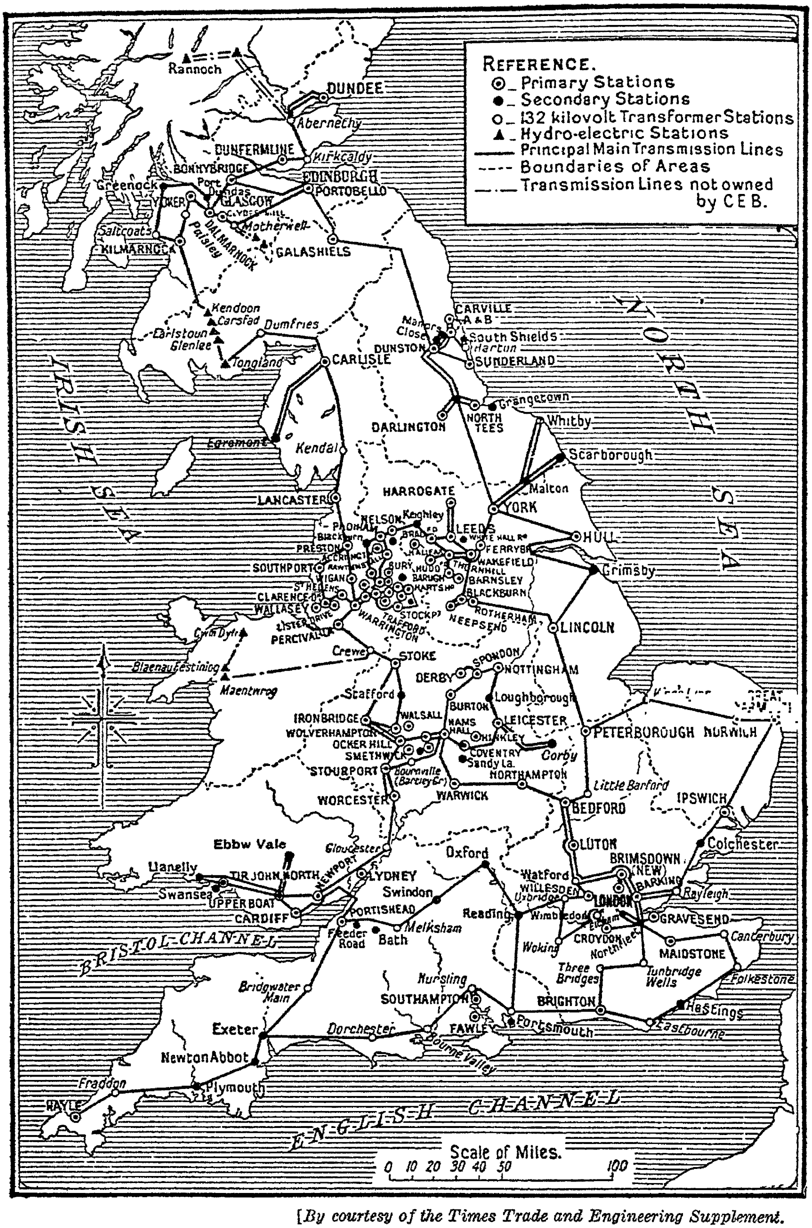
A glance at the map will show that the primary generating stations fall into three main groups:

(*a*) those situated on the coalfields and where the fuel required is directly at hand;

(*b*) those situated along the coasts or bordering tide-water where water-borne coal can be received at minimum cost;

(*c*) those situated near important inland areas of consumption which are not on coalfields. It is clear that these stations have been restricted in number as far as possible.

The map also illustrates the relative unimportance of hydro-electric power works in Britain, though the map does not show the works in Western Scotland (see p. 95) or the small works on the Dee at Chester.

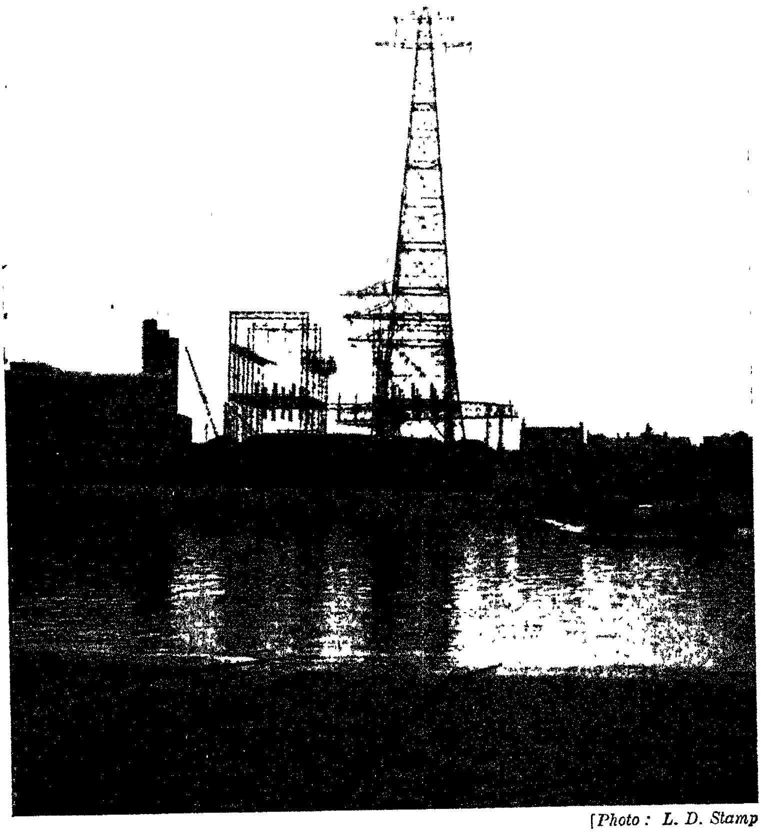


[*By courtesy of the Times Trade and Engineering Supplement.*

FIG. 225.—Map of the Main Grid Transmission Lines.

By the end of 1936 there were 4,125 miles of transmission lines with 137 selected generating stations and 289 switching and transforming stations. The cost to that date was £30,000,000. 12 million tons of coal were used in that year and over 20,000,000,000 units generated. The double lines in the Lake District and Yorkshire are lower voltage transmission or distribution lines.

There is still enormous scope for electrical development in Britain. In 1931 it was calculated that only 33 per cent. of the homes of Great Britain had an electricity supply, and there were still 8 million without. The average annual consumption



[*Photo: L. D. Stamp*

FIG. 226.—Power lines crossing the river Clyde.

Notice the main road ferry serving Renfrew.

was of the order of 500 units per home, and the output for the country some 10,000,000,000 units. By the end of 1936 this had doubled. The big increase year by year has been for domestic requirements rather than for factory undertakings.

The Leather Industry

In its distribution the fur industry of Britain is almost entirely distinct from the ordinary leather industry. The dressing and preparation of furs is very largely restricted to London where, in the East End, it occupies a large number both of men and women, the women outnumbering the men in this industry (see Chapter XXVIII). With regard to the leather industry, properly speaking, the distribution of the occupation of tanning in these islands is one of very considerable interest. It is an old industry, and in medieval times the two great requirements were—(*a*) a supply of cattle-hides and sheepskins, and (*b*) a supply of oak bark, since the principal source of the tanning extract was from this raw material. There was naturally a large and constant supply of hides from the damp cattle pastures of the Midlands of England, and consequently a tendency for the concentration of supplies in the market towns situated on the navigable rivers in the valleys of the region. Thus the tanning industry of Northampton, the natural geographical centre of the fertile river Nene basin, dates back a very long time. The oak forests which grew both on the damp lowlands of central England and also on the drier sandstone ridges, such as those of the Bunter sandstones, supplied the necessary tanning material. The importance of the character of local waters in the location of industries has already been apparent in the textile industries, and its effect was also of great significance in the location of tanning. Once again there is the desirability of soft water, and an absence of tanning works in those areas where the water contains large proportions of calcium bicarbonate in solution. Another centre of early importance was the natural focus of the great agricultural region of East Anglia, that is, Norwich. At a later stage the home production of hides and skins no longer furnished sufficient material for the leather industry. In 1928 the total imports into the United Kingdom of raw hides and skins of sheep and goats and partially tanned material of ox, cows, sheep, and goats requiring further treatment were valued at £21,000,000[1] sterling, re-exports were valued at £5,500,000, leaving for consumption in the United Kingdom raw material to the value of £15,500,000. The same year the value of the home supplies of hides and skins was estimated at £5,800,000, representing actually the value of 2,300,000 cattle hides, 1,100,000 calf skins, 11,500,000 sheepskins, less a proportion of these raw hides and skins which was exported. The imports of hides are derived from India, usually partially tanned, Italy, Germany, the Argentine, usually as wet hides, the Union of South Africa, India, and a considerable variety of cattle-rearing countries as dry hides. Sheepskins come naturally, in the main, from the great sheep-rearing countries of Australia,

[1] In 1935 a little over half these values. In 1936 wet hides were mainly from Argentina, Ireland, and the Dominions (with few from Germany and none from Italy).

New Zealand, and the Union of South Africa; goatskins mainly from India. With this huge import of raw material it is natural that there should also be a large tanning industry at the great ports. This tanning industry is particularly significant in London (see Chapter XXVIII) and Bristol. Thus there are two types of area where the leather industry is important at the present day:—

(*a*) The old centres in the heart of the country districts, particularly at Northampton and Leicester, as well as in Somerset and parts of the Kesteven district of Lincolnshire, and also in numerous other centres scattered throughout the country.

(*b*) In the areas near the great ports, of which London is the outstanding example.

The Boot and Shoe Industry, together with other Leather Manufactures

According to the census returns the making of leather goods is very widespread throughout the rural counties of England and Wales. These leather workers are, in the main, saddlers whose occupation is still one of importance although decreasing with the increased mechanisation of agriculture. The factory industry, on the other hand, and the manufacture of bags, trunks, saddlery, and similar articles of leather, tends to be concentrated very much in the Birmingham area, principally at Walsall. In the Middle Ages Birmingham was a natural centre on a somewhat infertile upland for the surrounding rich fertile lowlands, and it is from this beginning that the iron industry, or rather the hardware industry, of the Birmingham area developed—at first in response to the local demand of farmers for horseshoes, horse nails, chains, and other necessities of the farm. Similarly, the leather industry may be regarded as having grown out of this early response to local farming requirements and the local supplies of raw material. Although fabrics of very varied character now enter into the manufacture of women's shoes, the shoe-making and boot-making industry has definitely grown out of the leather industry; but it has become concentrated in a remarkable way in a few areas. Of approximately 90,000 factory workers no less than 60 per cent. are found in Northampton and Leicester, 33 per cent. in the first case, 27 per cent. in the second. Another leading centre is Norwich which at the present day specialises particularly in fancy footwear for women. In this case the industry was definitely encouraged to replace the dying textile industry—which it has most successfully done. Another centre, of less importance, is Bristol. In Scotland Kilmarnock is a leading centre.

The Clothing Trade

Every one must wear clothes; and it is scarcely too much to say that the little dressmakers' and tailors' establishments which

were so important in the past still persist in towns of almost every size up and down the country; but the large-scale manufacture of articles of clothing has become concentrated in a number of distinct centres, and it is perhaps because the requirements of clothing are broadly proportional to the population that these centres are the great conurbations. It would seem that the proximity of the market is more important than local supplies of raw material, though that too is seen to exercise an important influence in a number of areas. A leading place amongst the list of centres must be given to Leeds, not only because it contains the largest number of clothing operatives and because the variety of clothing trades carried on within its boundaries is very great, but because it is really the only large town of which clothing may be said to constitute the staple industry. The influence of the Yorkshire woollen industry is seen in the character of the clothing industry of Leeds, which specialises in outer garments of which wool is the chief material. In Lancashire, where Manchester is the principal clothing centre, dresses of light material, shirts, and underclothes are more important, obviously again indicating the importance of the local supplies of cotton fabrics. The Manchester industry spreads to Stockport and to Wigan, whilst that of Leeds spreads to Halifax and Huddersfield. A third centre is afforded by Birmingham, Walsall, and neighbouring towns of the Midlands. A perhaps greater geographical interest attaches to the group of clothing manufacturing towns in the west of England of which Bristol is the centre; it also includes Gloucester and the Stroud valley, Taunton and elsewhere. Doubtless the clothing firms here are a legacy of the once important cloth industry, now largely disappeared. It is natural that the hosiery centres of Nottingham, Leicester, and Kettering should not cease with the manufacture of knitwear, but should include also the manufacture of underclothing of different types. In the southern and eastern counties there are many towns, such as Colchester, Norwich, Portsmouth, Basingstoke, and Reading which have individually quite important clothing industries, but it is in Greater London that one finds again the industry really important, the number of clothing workers being about 150,000 (see Chapter XXVIII). Luton, in Bedfordshire, is the chief centre in Britain for the manufacture of hat shapes, an interesting modern development of the former domestic industry in straw plaiting and weaving which in turn was the result of a situation in the midst of a rich cereal-growing country. In Scotland there is really only one important clothing centre—Glasgow. Reference is made in Chapter XXX to the clothing industry in Ireland.[1]

[1] The manufacture of gloves may be linked more closely with the leather industry, and it is associated with certain towns in rural areas, of which the most important is Worcester; the other counties concerned being Oxford, Wiltshire and Dorsetshire. In a large number of areas the clothing trade tends to become established in centres where some heavy industry engages the males, leaving an available surplus of female labour for lighter work, *e.g.* corsets in the dockyard city of Portsmouth.

The Preparation of Food, Drinks and Tobacco

Naturally, if one includes bakers, workers in the preparation of foodstuffs are very widespread throughout the country. Apart from bakers the persons enumerated in this category of the Census fall into two main groups :—

(*a*) Those employed in the larger market towns of the British Isles which utilise local agricultural produce. In many cases local supplies continue to be more important, *e.g.* for mustard and patent groats at Norwich; in others local supplies of agricultural raw material have been supplemented by imported materials of a similar character. In some cases perhaps a traditional occupation has attracted the establishment of allied factory industries, but one must beware of seeking too easy an explanation for the biscuit industry of Reading, London, Liverpool, and Carlisle.

(*b*) The second group comprises persons employed in the great ports and associated areas. Grain milling in particular tends to be concentrated at the larger ports, whilst the preparation of imported foodstuffs is well illustrated by the chocolate and confectionery industry of Bristol, the sugar refining of the east of London, the margarine industry of the Liverpool neighbourhood, and the oil and oil-cake mills of Hull. But the association of chocolate with York and with the Birmingham neighbourhood can scarcely be explained so simply on a geographical basis. The brewing and distilling industries have already been considered. The preparation of tobacco is not unnaturally associated with the great ports—London, Bristol, and Liverpool (29, 23, and 9 per cent. of the workers respectively, according to the census of 1921). The largest inland centre is Nottingham.

Wood Working and Furniture Making

Carpenters are, of course, found all over the country, but the two great centres for wood working, particularly furniture making, are in Buckinghamshire (the chair-making and cabinet-making industry of High Wycombe) and London (see Chapter XXVIII). More than 10 per cent. of all the males engaged in wage-earning occupations in the county of Buckinghamshire are wood workers. It is possible to trace some connection between the establishment of the industry and the beechwoods of the Chiltern Hills.

Paper Making

The majority of paper used is cheap paper, for which the raw material is wood pulp, of necessity imported and of necessity bulky and of low value relative both to bulk and weight. The finished

product, especially of newsprint, is again of low value. Hence the dominating factors determining the situation of the factory are soft water in abundance, proximity to tide water and accessibility of large consuming centres. The banks of the Thames in north Kent supplying London's requirements, Rossendale (especially the northern flank—using the port of Preston) supplying Lancashire and the requirements of north England, and Rutherglen supplying Clydeside, are thus of outstanding importance. With better types of paper, some of which are still made from rags, the purity of water is a still more important consideration. Originally each mill had its own characteristic product and the standardised machine-made product only superseded the hand-made article during the nineteenth century. Fine paper, where suitable water supplies are available, is made in northern Somerset where a mill near Wookey Hole has been working since the reign of James I, and in parts of Hampshire (where paper for Bank of England notes is made).

Printing, Bookbinding, and Photographic Trades

Of the workers enumerated in England and Wales, approximately half are concerned with London as the great centre. It is true that they are not by any means all in the administrative county, or even in Greater London, for many printing firms have, for reasons of economy, migrated to towns which, although accessible from the metropolis, are outside the administrative boundary. Thus, this book is printed at Beccles, in Suffolk. Other well-known firms choose locations such as Colchester, Guildford, Maidstone, Rochester, etc. There is an interesting association still between the printing, bookbinding, and publishing trades and the great centres of learning. One may cite particularly Edinburgh in the case of Scotland, Oxford in the case of England. The industry employs 250,000 people.

The Rubber Industry

The rubber industry may be quoted as an example of an industry of comparatively recent origin which illustrates the varying strength of factors determining location. The raw material is, of course, of equatorial or tropical origin, and must be imported. One would therefore expect the industry to be concentrated near the great ports. On the other hand the question of market arises. A large proportion of the rubber is required for tyres for the motor industry, and in connection with the electrical industries which have become established—particularly in the Birmingham area and the old Black Country. This has proved the stronger factor, and hence the rubber industry is particularly in Birmingham and neighbourhood, and in the Manchester district, responsible between them for nearly 40 per cent. of all the workers engaged in the industry (1931).

Oil Refining

Oil refining offers a contrast to the industry last considered. Again, the raw material, the crude oil, is entirely imported, but in this case it is a bulky commodity, one unsuitable for land transport and requiring special installations for storage purposes. Because of the element of risk from fire and the necessity for special accommodation for the handling of oil tankers and the transfer of their cargoes to the storage reservoirs, the oil-importing industry is restricted to what are really special ports, although they are situated in reasonably close proximity to some of the major ports. At the ports of import refining is carried out, so one has Thameshaven and Shellhaven near the mouth of the Thames, the large oil refineries at Llandarcy near Swansea, at Avonmouth, at Glasgow, and near Southampton.

The Building Industry

The building industry could rightly be accorded a chapter on its own, since it employs directly 5 per cent. of the occupied male population and, with painters and decorators and allied trades, some 10 per cent. or 1,000,000 workmen. In the year ended September 30th, 1936, a record number of 340,000 houses were built in England and Wales, and the value of buildings erected in 1936 was at least £120,000,000 or double the total for 1924. The activity is naturally greatest in that area described below (p. 553), especially in Greater London, where there is the greatest expansion of population and of industry. Nearly two-thirds of the total expenditure is on dwelling-houses.

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CHAPTER XXV

THE PEOPLING OF THE BRITISH ISLES [1]

Two sets of factors may be said to have exercised a dominating influence on the early peopling of the British Isles. The first set of factors is climatic, the second set of factors is physiographic. There is no doubt that there were human inhabitants in the British Isles before, or at least in the earliest stages of, the great Ice Age. As glacial conditions spread southwards so man was forced to retreat before the advancing cold, and left the open valley bottoms and took refuge in caves. But it is clearly incorrect to picture a continuous southward spread of glacial conditions and then a continuous northward retreat. Periods of intense glaciation were succeeded by comparatively warm inter-glacial periods which in turn were terminated by a renewed onset of colder conditions. The extremely difficult, if fascinating, work of correlating the glacial and inter-glacial deposits of this country and of tracing their connection with the movements of early man is one which has for long periods unceasingly occupied the attention of both geologists and archæologists. The present state of knowledge has been well summarised by Professor P. G. H. Boswell in his presidential address to Section C of the British Association for the Advancement of Science, York, 1932. If we consider the period of maximum extension of glaciation we may rightly picture the whole of Ireland and the whole of northern Britain, as far as a line joining the mouth of the Thames and the mouth of the Severn, as being covered by ice sheets of greater or less extent and of varied origin. At this period the extreme south of Britain, therefore, would be occupied by land comparable in climatic and probably in vegetational characteristics with the great Tundra lands of the present day. On these Tundras or Arctic grasslands the reindeer, amongst other animals, flourished, and attracted the attention of early man, the hunter. When the ice sheets finally retreated these Tundra grassland conditions moved gradually northwards and probably man, still the hunter, went with them. The place of the Tundra in Britain was then gradually taken by forests, probably in the first instance forests with a large proportion of coniferous trees,

[1] The authors wish to express their thanks to Professor H. J. Fleure for his comments and criticism on part of this chapter, and also to their colleague, Mr. W. G. East. Since the first edition of this book was published there has appeared the important collection of fourteen studies, entitled *An Historical Geography of England before* A.D. 1800, edited by H. C. Darby, Cambridge Univ. Press, 1936.

and then by the deciduous forests which form the characteristic natural vegetation of these islands at the present day. The spread of forest increased the difficulty of sustaining life from the spoils of the chase, and so encouraged the settlement of man in more open areas on the uplands [1] and along the coast. The coast dwellers apparently obtained shell fish, and their implements are of "Tardenoisian" type. Later came the introduction of primitive agricultural and domestic animals, probably by invaders who were forerunners of the Megalithic and Beaker peoples. With the development of a more settled life there was no longer the necessity to be continually on the move, and several writers have properly stressed the importance of the change, especially on child life. No longer was it necessary for the children to be carried about continuously on their mother's backs. Infant mortality lessened, and there was an increase in the population, and with the increase an improvement in moral and physical conditions. It must be remembered that simultaneously the great vegetation belts of the world which we know at the present day must have moved northwards, and this northward movement of environmental conditions with which they were familiar in itself encouraged the northward movement of peoples. This invited naturally a migration into, and a settlement of, Britain from the Continent.

The main physical features of the British Isles profoundly affected the lines of movement both of traders and of settlers. Prehistoric immigrants who entered Britain from the south or from the east spread westwards and northwards, though avoiding the thickly forested clay lowlands and using as their avenues of movement, for the most part, the more open hill-belts. Their movements were stopped, or at least hindered, by the hilly barriers afforded by the Pennines, the edge of the Welsh massif, and the hills of Devon and Cornwall. It might be thought that they would penetrate through what is now called the Midland Gate into the plain of Cheshire and Lancashire and thus reach the Irish Sea, but it would seem that that lowland was covered by a very heavy growth of damp forest which prevented access to the western seaboard. Later, it is clear that during the Roman period the settlements of the Romano-British population were limited to the "lowland zone," and it is still clearer when one comes to the succeeding period and considers the distribution of Anglo-Saxon settlements. On the other hand there was the stream of traders and settlers who approached the British Isles by the sea-way from the west and south-west. It is clear that, though they were able to spread over the whole of Ireland, their colonies were largely restricted to the coastlands of Devon, Cornwall, the Scillies, Wales (especially Glamorganshire, Pembrokeshire, Carnarvonshire, and

[1] *E.g.* the Pennines: see Petch *Publ. Tolson Museum, Huddersfield.*

Anglesey), the Isle of Man, the Western Isles and adjacent coasts of Scotland, Orkney, Shetland, the plain of Caithness, and the shores of the Moray Firth. Only when they had overcome the intervening mountain barriers—and still more the forest and marsh barriers—were they able to descend upon, or mingle with, the people of the lowlands to the east. It was not apparently till a much later stage, that of the Scandinavian invasions, that a movement of people coastwise from the north of Britain became important. There is, thus, in the peopling of Britain a fundamental distinction to be made between the lowland zone of the south and east and the highland zone of the north and west. Already, before the dawn of written history, a frontier region of peoples and cultures came into existence between the two. The dividing line between the zones corresponds roughly with the outcrop of the youngest Palaeozoic rocks. It would seem that the distinction between the two zones has been preserved for several reasons. Amongst them two stand out. One is that until the extensive clearance of forests in the lowland zone the habitable regions were mainly those raised some distance above sea-level, forming islands of habitable or cultivable land in a sea of forest, and where those more readily cultivable regions reached the coast there grew up the trading centres. By way of contrast the cultivable or habitable regions amongst the hills of Scotland or Wales were the valley regions, which may be described as islands of inhabitable country within a sea of comparatively useless hills. In the second place the lowland zone is that neighbouring to, and easily accessible from, the Continent, and so successive waves of invaders came in and imposed their culture, and often their racial characteristics, on the existing inhabitants. On the other hand, in the highland zone, such of the few invaders as penetrated into the valleys tended to be absorbed by the existing population. This is important, because it helps to explain the persistence of differences between the Highland Scot or the Welshman on the one hand, and the English lowlander on the other.

A few years ago in a little book on the "Races of England and Wales,"[1] Professor H. J. Fleure presented a summary of the main results of recent research on the pre-Roman peopling of the British Isles. Still more recently a particularly interesting and well illustrated summary has been drawn up by Sir Cyril Fox.[2] Fox shows how after the final retreat of the ice, but earlier than 2,000 B.C., a powerful Megalithic civilisation spread over the whole of Ireland and the highland zone of Britain, including the plateau of Caithness and the lowlands round the Moray Firth. The culture had been brought by sea from the south and west, that is from Spain

[1] Benn Brothers, Ltd., London, 1923.

[2] *The Personality of Britain—its Influence on Inhabitant and Invader in Prehistoric and Early Historic Times.* National Museum of Wales, Cardiff, 1932.

and Atlantic France. The invaders were the builders of the dolmens and other huge stone monuments which are still found widely distributed in Ireland. In Britain they evidently pressed eastwards, and the stone circles of Stonehenge and Avebury are evidence of the importance of their dominance in the Salisbury Plain region. The builders of the great stone monuments seem to have been longheaded people, probably of short stature and dark skin, and the evidence points to them as the oldest large element in our population. They buried their dead in long barrows, and hence they are sometimes known as "long barrow" people.[1] Simultaneously the east of Britain seems to have been strongly influenced by a Neolithic culture of peoples coming from the east, from the Baltic region, or possibly from further eastwards from the Kiev region or from Upper Silesia, passing on their way to Britain through Denmark and Holland. In Britain the remains of these people, often known as the "Beaker" people as they are associated with rough pottery of curious form known as beaker pots, are left most characteristically along the east coast from Caithness to the Humber, and in the south-east, where they evidently penetrated along the chalk ridges. If the earliest arrivals brought no metal, copper and bronze daggers were a little later commonly buried with the dead. They buried their dead in round barrows. Burials of the succeeding stage were also in round barrows, but usually in cinerary urns, since by that time the corpses were generally burnt. The Beaker people were short-headed people, thus allied in character to the Alpine race of the Continent of Europe, or perhaps a Nordic-Alpine cross, whereas the Megalithic people may be said to be allied to the Mediterranean races of Europe. For the next stage in the peopling of Britain Fox gives the provisional date of about 2,000 B.C.

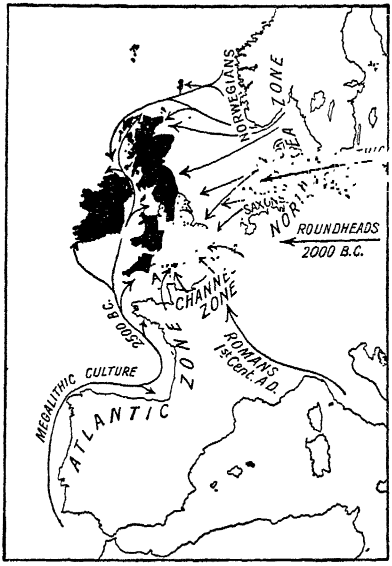

FIG. 227.—The routes from Europe into Britain followed by early traders and invaders.

The "highland zone" is shown in black; the "lowland zone" by dots. A and B = routes followed by invaders and traders of the late Bronze Age; B = routes followed by Romans.

[1] Some authorities regard the long barrows as a variety of megalith, belonging to a zone farther east than the true megalith and of doubtful cultural derivation.

The invaders were from the east, the Nordic-Alpine roundheads (predominantly but not exclusively roundheaded) who came and occupied the whole of the lowland zone and penetrated far into the highland zone. They made Salisbury Plain an important centre and assimilated some of the Megalithic traditions and possibly reconstructed Stonehenge.[1] The trade from the south-west also developed at this time and the Hampshire " Gate " seems to have been used for the importation of bronze tools which were taken *via* Salisbury Plain to the Midlands and possibly through the Bala cleft into Wales. Many of the people of the south-eastern lowlands, however, were too poor at the time to acquire these imported tools. Almost contemporary with this, Fox says, a new source of copper and bronze tools was opened up in Ireland, and these Irish products were traded in both highland and lowland Britain. There was at this time an important trade in Irish gold (obtained in the Wicklow Mountains) to the Continent, and this trade seems to have been captured by the lowland people of Britain. By 1,000 B.C. (in the late Bronze Age) there was marked activity in trading. New invaders brought with them a high culture and developed metallurgy, particularly the art of bronze working, in Britain itself. They entered the country by the east and south coast estuaries and seem to have been most active in the Thames Basin—the middle and lower Thames valley. Here during the last five centuries B.C. the Bronze Age gave place to the Iron Age, and close contact developed between the iron-sword makers of south-eastern England (Iron Age " A " culture) and the neighbouring parts of the Continent, with the result that the south-east had a cultural pre-eminence, and strong British kingdoms had their capitals at St. Albans and Colchester. At the same time there seems to have been an important cultural centre (Iron Age " B " culture) in the south-west, probably connected with the exploitation of Cornish tin, and the consequent stimulation of the old sea routes to the south-west.

In 43 A.D. the Roman conquest of Britain began by an entry in the south-east and an advance north-westwards towards the Thames. A Roman commercial centre was quickly established at London, and a uniform civilisation was imposed on the lowlands. Two maps are given here to illustrate the Roman occupation of Britain. The first shows the area with civil settlements in Roman Britain, and the remarkable way in which the civil districts correspond to what has been described in this work as the " lowland zone " will be noticed at once. The Romans established cities and farms (*villae*), and made their long straight roads all over the lowland zone. In the highland zone they established military camps and military districts, but not Romanised civil settlements, though roads were extended from the lowlands into the highlands. This

[1] Forty of the lesser stones of Stonehenge were brought from Pembrokeshire.

is shown very clearly in the second map. The distribution of Roman villas in the country—almost restricted to the lowland zone—illustrates once again the significance of the division between these two fundamental parts of Britain.

In the fifth and sixth centuries A.D. history repeated itself. This was the period of the invasions, conquest and colonisation of the British lowlands by the barbarian Angles and Saxons. The maps, Figs. 230, 231, show clearly how the political and cultural divisions of England in the sixth century A.D. illustrate once more the contrast between the Lowland Zone and the Highland Zone; the Lowland Zone completely Anglo-Saxon, the Highland Zone

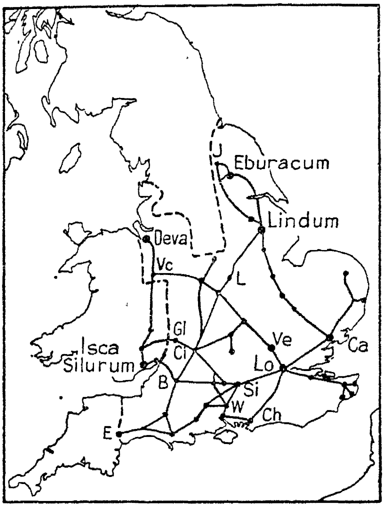

FIG. 228.—The Civil Districts of Roman Britain (*after Haverfield and Macdonald*).

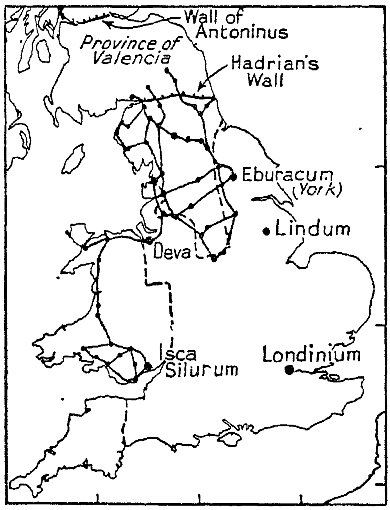

FIG. 229.—The Military Districts of Roman Britain (*after Haverfield and Macdonald*).

The chief Roman roads connecting (Fig. 228) the civil settlements, and (Fig. 229) the military posts.

remaining Celtic. Thus, since the Anglo-Saxons were pagans at first, the Celtic Christian Church was cut off from the Roman Christian Church of the Continent. Many of the earlier writers on the early history of Britain fell into the error of thinking that all invasions of Britain—cultural and military—had come from the east, and that each invasion in turn had pushed the earlier peoples into the highland fastnesses of Scotland and Wales, and into the outpost of Ireland. We have seen that this is fundamentally wrong; and it can again be proved so during the fourth, fifth, and sixth centuries A.D. when there was extensive colonisation from Ireland of the western coasts of Scotland (where the Scots from Ireland drove out the native Picts in Argyllshire), Wales, the south-western

peninsula and Brittany; and it was indeed the coming of these Irish to western Britain that spread alarm in the waning years of Roman rule. The Anglo-Saxon colonisation largely "fixed" the settlements of at least the lowland zone and the process was later extended.

It was in the eighth, ninth, and tenth centuries A.D. that a new movement of invasion and colonisation occurred which had a lasting influence on parts of Britain. This was the invasion of Vikings or Scandinavians which was mainly from the north-east. They colonised the Shetlands and Orkneys, and a broad coastal fringe of

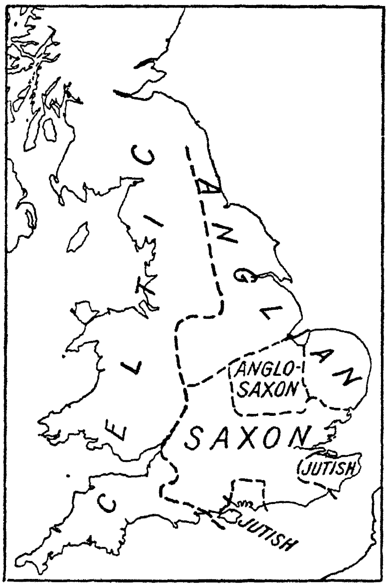

FIG. 230.—Cultural zones of the Angles, Saxons and Jutes in Britain A.D. c. 550 (*after E. T. Leeds*).

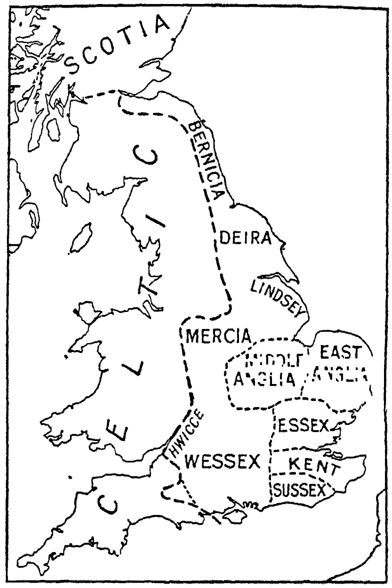

FIG. 231.—Anglo-Saxon Britain at the end of the sixth century A.D., showing the kingdoms. Notice the significance of the Forth as a barrier (*after E. T. Leeds*).

northern Scotland, including most of Caithness.[1] Southwards they colonised many places, as the distribution of Scandinavian place names shows, in eastern Britain, tending to remain on the whole along the coast, though spreading far inland along the estuaries of navigable rivers. Another stream of Scandinavian invaders passed down the western coast of Scotland, colonising at intervals as they went, and forming a broad area of settlement in what is now the Lake District and Lancashire. They showed themselves

[1] The Viking invasions so weakened the Picts of Scotland that they were conquered with ease by the Scots under Kenneth Mac Alpine who thus became the ruler of the united Picts and Scots.

adept at recognising the more important ports of entry into Ireland, colonising round Dublin, Waterford, Cork, and Limerick. In the meantime, it should be noticed, the Anglo-Saxons had penetrated further northwards and had colonised the east of the Midland Valley of Scotland as far north as the Forth, where Lothian formed the northern part of the Kingdom of Bernicia.[1] Thus we see the British Isles at the time of the Norman Conquest with an Anglo-Saxon or Lowland Zone, a Celtic-speaking Highland Zone, and an

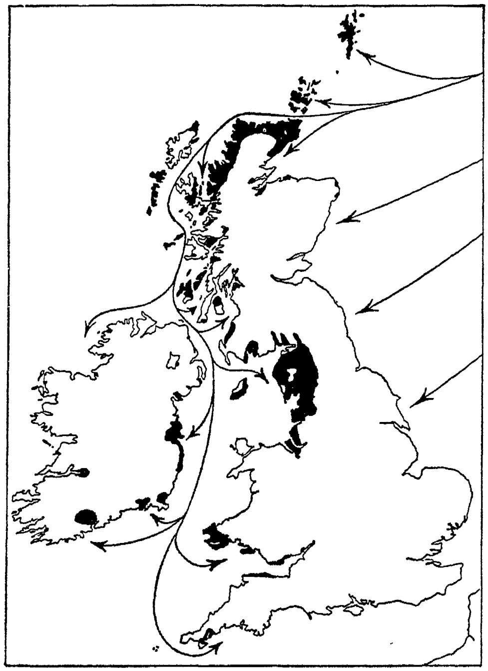

FIG. 232.—The Viking Settlements of the eighth, ninth and tenth centuries.

It is not possible to indicate precisely the sphere of influence in eastern England, where Scandinavian influence penetrated irregularly into the lowland zone (*after Fox*).

important Scandinavian fringe. The Romans had imposed their rule and to a considerable degree their language, but can scarcely be said to have altered the racial characteristics of the inhabitants of these islands.

This brief summary of the peopling of these islands may be concluded by noting one or two movements of later peoples; such, for example, as the arrival of Flemings and Huguenots, who often

[1] On the importance of the Firth of Forth as a geographical barrier and the origin of the present Scottish counties, see W. C. Dickinson, "The Sheriff Court Book of Fife," *Scottish History Society*, 1928.

had an important and lasting effect on the development of economic life in this country. The second of these is the intermittent incursions and peaceful settlement of western Scotland by migrants from Ireland, particularly early in the seventeenth century during the reign of James I of England.

Having learnt now something of the various strains of people that have gone to make up the British nation, we may turn to a consideration of the distribution of population in the islands.

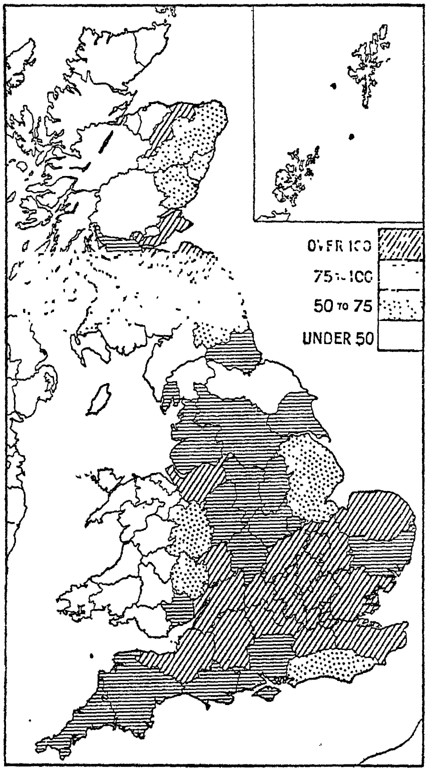

FIG. 233.—The population of Britain in 1700 per square mile (Scotland in 1755).

The densest population was in the better agricultural areas: the coalfields had not yet exerted their influence.

To Scotland falls the honour of having taken the first census in Britain, compiled in 1755 by Dr. Alexander Webster, minister of the Tolbooth Church in Edinburgh. Webster used his influential position as Moderator of the General Assembly in 1753 to secure from the parish ministers a return of the number of souls in their parishes, differentiating the two groups of Protestants and Papists. These early records of Scotland are particularly interesting since they show the distribution of population just prior to the period when Scotland changed from an agricultural and fishing country to one characterised by large scale industrialisation in the Central Valley. Thus, in 1755, the most densely populated counties in order were Banff, Berwick, Midlothian, Clackmannan, Fife, and West Lothian, all, it will be noticed, on the drier eastern side of the country which has already been shown (see Chapter XI) to be the most suitable agriculturally to support a considerable population. It will be seen that the Midland Valley counties had not at this time succeeded in drawing to themselves the large populations which characterised them shortly after. It was largely owing to the

influence of Malthus and the not inconsiderable stir that his predictions produced that the first official census of the British Isles was taken in 1801. From that time onwards the census has been taken every ten years, and the table given below shows the population of each of the constituent parts of the British Isles at each census and also the decennial rate of change. Throughout, the rapid

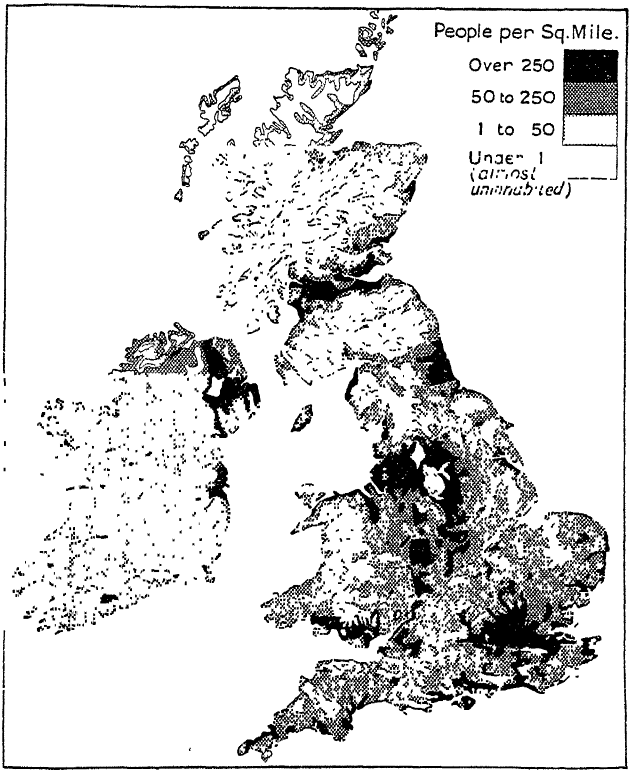

FIG. 234.—The present population of the British Isles.
The divisions correspond roughly with industrial and intensive agricultural, good agricultural, poor agricultural, and remote moorland tracts.

increase at first and then the diminishing rate of increase is clearly indicated. An attempt has also been made to incorporate the effects of migration. Of course the key note of the last hundred years has been industrialisation—the increase of the industrial and urban population—accompanied by rural depopulation. An actual decrease in population did not set in as a rule until about the middle

of last century or later. A study of the movement of population county by county, indicates at first a rise, practically speaking, in all counties, then a general decrease in the rural counties, but continued increase in all those counties which had industries. Quite frequently even the possession of a small industrial tract on the county margins was quite sufficient to turn the scale as, for example, in Denbighshire and Flintshire in Wales.

But because the general movement of population was from the

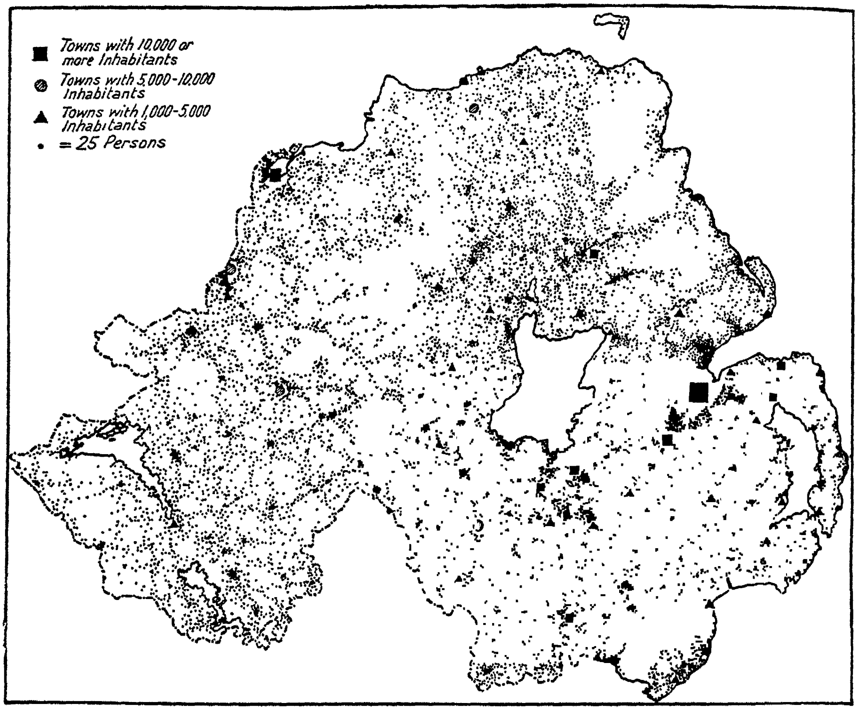

FIG. 235.—Population map of Northern Ireland (1926).

This map was constructed by taking each dwelling-house marked on the Ordnance Map, calculating the population at 4·5 persons per house. The map illustrates the well distributed rural population. (*Map constructed by Miss D. M. Fisher.*)

country to the towns it must not be presumed that all towns have increased in size. The rise and fall of settlements will be discussed in the next chapter. But whilst continued growth is the rule in the great urban agglomerations, which once they attain a certain size tend to increase of their own momentum, some of the smaller towns, especially those in Scotland, are losing their population at a greater rate than even the purely rural parishes. It is scarcely necessary to emphasise the way in which the coalfields have been the magnet for the attraction both of industries and the population

which went with the development of industries. Exceptions were few. Naturally some of the larger ports continued to attract a population as their trade developed, but in reality they were serving for the most part as inlets or outlets for the industrial regions on the coalfields. The one main exception was London, in so far as its

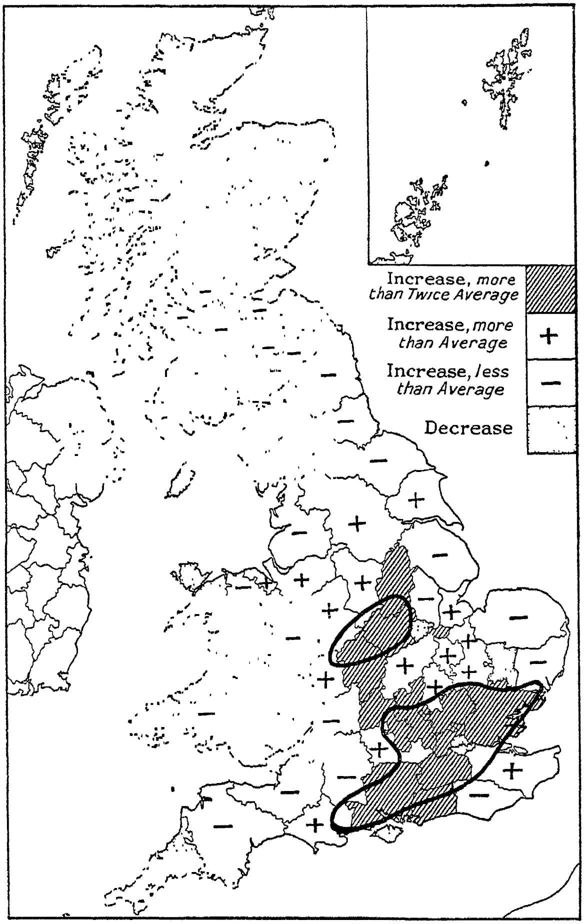

FIG. 236.—Population changes in Britain 1921–31, illustrating rural depopulation.

The heavy lines enclose the two areas of greatest increase. Nearly all the poorer agricultural counties—and many of the richer—show a decreasing population (*after C. B. Fawcett*).

relationship to the coalfields is concerned, but after all London is really the port for the greater part of Britain. But post-war years have brought about a distinctly new tendency. It may be described as the flight of industry *from* the coalfields, in large measure of course due to the more extensive use of electricity which, if generated by

coal, can be generated on the coalfields and transmitted where required. To sum up the post-war tendencies (which have been analysed by Professor Fawcett), the intercensal period of 1921–31 may be described as showing continued rural depopulation, virtual or actual cessation of growth, and in cases even a decrease in the population of industrial regions and towns in the north compensated for by the continued phenomenal growth of London and of the development of the London region as a whole as a manufacturing

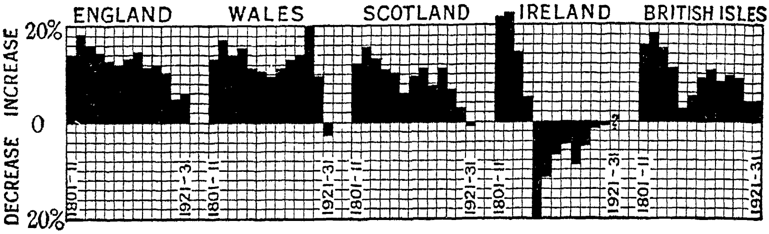

FIG. 237.—Population changes in the British Isles, 1801–1931, showing decennial changes.

area. Industry has not only started to move south, it is continuing to move south.[1] This is brought out very clearly by the map which is based on that prepared by Professor Fawcett.

At first it might be thought that Ireland offers a different picture from the rest of Britain. But that is not actually the case. Ireland is essentially rural, and so has suffered depopulation in the same way as all rural parts of the British Isles. But as the diagram (Fig. 237) shows, depopulation has been continuous since the decade 1841–51, and was initiated by the great famines of the 'forties.

POPULATION

	British Isles	England and Wales	Scotland	Ireland
1801 . . .	—	8,892,536	1,608,420	—
1811 . . .	—	10,164,256	1,805,864	—
1821 . . .	20,893,584	12,000,236	2,091,521	6,801,827
1831 . . .	24,028,584	13,896,797	2,364,386	7,767,401
1841 . . .	26,730,929	15,914,148	2,620,184	8,196,597
1851 . . .	27,390,629	17,927,609	2,888,742	6,574,278
1861 . . .	28,927,485	20,066,224	3,062,294	5,798,967
1871 . . .	31,484,661	22,712,266	3,360,018	5,412,377
1881 . .	34,884,848	25,974,439	3,735,573	5,174,836
1891 . . .	37,732,922	29,002,525	4,025,647	4,704,750
1901 . . .	41,458,721	32,527,843	4,472,103	4,458,775
1911 . . .	45,213,347	36,070,492	4,760,904	4,381,951
1921 . . .	—	37,886,699	4,882,497	4,228,553 *
1931 . . .	—	39,946,931	4,842,554	

* Census year 1926 for Irish Free State and Northern Ireland.

[1] Strictly the *industries* of the north are not moving south, but the south is attracting *new* industries and there is a population drift.

DECENNIAL POPULATION CHANGES (PERCENTAGES)

	British Isles	England and Wales	Scotland	Ireland
1801–11 . .	—	14·00	12·3	—
1811–21 . .	—	18·06	15·8	—
1821–31 . .	15·03	15·80	13·0	14·3
1831–41 . .	11·24	14·27	10·8	5·5
1841–51 . .	2·47	12·65	10·2	−19·8
1851–61 . .	5·62	11·90	6·0	−11·8
1861–71 . .	8·55	13·21	9·7	−6·7
1871–81 . .	10·80	14·36	11·2	−4·4
1881–91 . .	8·16	11·65	7·8	−9·1
1891–1901 .	9·89	12·17	11·1	−5·2
1901–11 . .	9·04	10·89	6·5	−1·7
1911–21 . .	—	4·93	2·6	−3·4 [1]
1921–31 . .	—	5·16	−0·8	

[1] 1911–26.

Note : The population of the Irish Free State decreased from 2,971,992 in 1926 to 2,965,854 in 1936.

NUMBER OF PASSENGERS OF BRITISH NATIONALITY LEAVING AND ENTERING THE UNITED KINGDOM FOR AND FROM COUNTRIES OUTSIDE EUROPE [1]

		1909–13	1926	1930	1933	1935
Emigrants	To the Empire . .	276,261	132,306	59,241	20,760	24,256
	To foreign countries		166,601	32,917	5,496	5,525
Immigrants	From the Empire .	104,340	39,079	51,442	44,642	35,785
	From foreign countries		11,984	14,761	14,682	10,459

[1] From Statistical Abstract of United Kingdom. 1926 was a peak year for emigration after the War, 1933 a low record.

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CHAPTER XXVI

THE EVOLUTION OF THE FORM AND FUNCTIONS OF BRITISH VILLAGES AND TOWNS

It seems clear that the settlements of Stone Age man were restricted to those areas where the natural vegetation cover was easily cleared (see p. 544). That such areas were available on the comparatively open belts, such as the chalk downlands of south-eastern England, is reasonably certain (but see p. 117), but it has been urged also that there were other sites, notably gravel plains in the valleys, which were equally attractive.[1] It is possible, as C. E. P. Brooks has urged, that in pre-Roman times the climate of these islands was more humid than at present, and that water supply in upland situations did not present the difficulty that it would do to-day.[2] The pre-Roman Briton relied upon the hoe for scratching the surface of the small square fields which he had cleared on the uplands or on the valley gravels, and this field system appears to have continued during the Roman occupation. It seems clear that the introduction of the eight-ox plough in Anglo-Saxon times produced a revolution in agricultural practice. In the words of H. J. E. Peake,[3] "it ceased to be economical, or even practical, to plough these little chessboard squares; for when the peasants adopted the new method of cultivation they divided the land into long narrow strips that were suitable for ploughing."[4] Whatever the origin of the common-field system with its two or three fields, it is certain that by early Saxon times the normal human settlement had four primary requirements. (1) A supply of water; (2) an area of good lowland grazing, *e.g.* water meadows on alluvium or by the side of streams; (3) Drier undulating land suitable for ploughing; (4) an area of common rough hill pasture for grazing. Such comprised a typical valley settlement. In the broader valleys the settlements would be on the banks of the stream, and the land

[1] E. T. Leeds: *Geography*, XIV, 1928, pp. 527–535. Probably, as suggested on p. 123, the alder-woodland of these damp areas was more easily attacked by men armed only with stone tools than oakwood or other types of forest.

[2] The more humid conditions may only have been experienced in the first millenium B.C. Prior to that a dry phase with warm summers seems to have occurred.

[3] "Geographical Aspects of Administrative Areas." *Geography*, XV, Part 7, pp. 531–546 (1930).

[4] The acre consists of four roods, a rod wide and a "furrow long" or "furlong" in length.

proper to the village would extend from the damp pastures along the banks of the stream to the high ground on one side of the valley. The villages might be at intervals of a mile or more along the banks with a corresponding line along the other side of the stream. In the case of narrower valleys the village itself might bridge the stream and its domain extend from the hills on one side to the hills on the other. In other cases a line of villages might be situated along

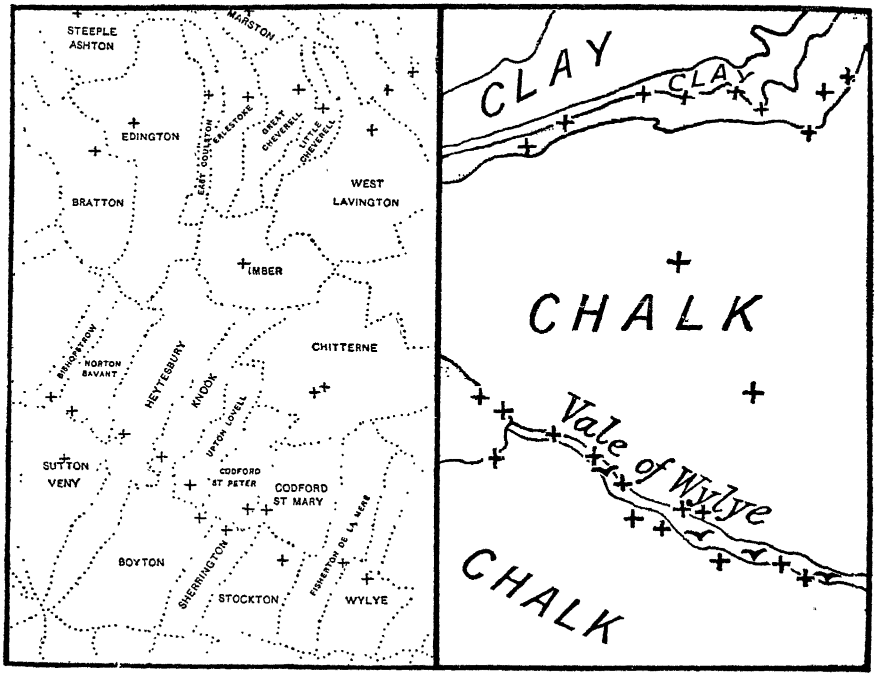


FIG. 238.—Wiltshire parishes.

Illustrating a line of valley settlements along the Vale of Wylye, with the village (the cross represents the parish church) near the stream in each case. In the north are "spring line" villages along the outcrop of the water-bearing Upper Greensand on the southern side of the Vale of Pewsey. (Scale 4 miles = 1 inch.)

a line of springs issuing from the hillside, the pasture land occupying the lower ground to the one side, the ploughed land and the rough pasture the higher ground to the other, giving what are known to-day as spring line villages.[1] It is thus clear how the vill or smallest unit of administration came into existence. It was the land proper to

[1] Both types of village correspond to what some continental authors have called "wet point villages." It is only in the wet marshy districts, *e.g.* plain of Somerset, that there is the necessity for the human settlement to occupy a drier point than the surrounding marshy lowlands, giving what may be termed a "dry point" village. See B. M. Swainston: "Rural Settlement in Somerset," *Geography*, XX, 1935, 112–124.

a single village or settlement and its boundaries were naturally so arranged that it included areas of the three types of land mentioned.[1] With the re-introduction of Christianity into Britain at the end of the sixth century A.D., it is natural that a church should be added to the existing settlements, and the vill took on a new aspect; it became the parish, the smallest unit of our existing administrative system and originally a purely ecclesiastical area. It was the district served by the parish church and indeed the area from which tithe is payable to a given church, or in the first instance

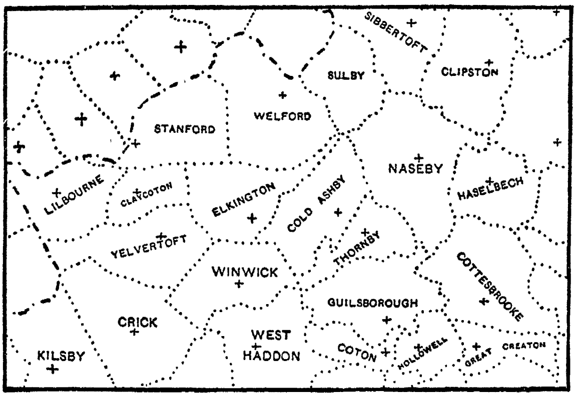


FIG. 239.—Regular-shaped parishes with the church or village centrally placed. Typical of the damp pasture lands—now predominantly permanent grassland—of the Midlands and clay vales. (Scale 4 miles = 1 inch.)

to the priest in charge. Examples are numerous in south-eastern England of the apparently curious shape of parish boundaries which are due to the old time necessity of including within the parish sufficient areas of the land of different types required by the rural economy of the period. Excellent examples are afforded in the south of Surrey in the parishes of Wootton, Abinger, etc. With the development of the manorial system sometimes the vill or township coincided not only with the parish but also with the manor. Sometimes, however, the vill had become divided into two or more manors, each of which had a parish church and so each became a distinct parish. Often the component parts in the original vill retained the old name, distinguished, however, by the addition of an adjective—such as the name of the lord of the manor or the saint to which the church was dedicated. Many of the picturesque names in the midland counties of England are thus derived.[2] It

[1] Vill seems a better term for these units than township, which tends to suggest an urban area.

[2] *E.g.* Compton Bassett, Berwick Bassett, Winterbourne Bassett (Wiltshire), Wiggenhall St. Germans, Wiggenhall St. Peter, Wiggenhall St. Mary the Virgin, Wiggenhall St. Mary Magdalene (Norfolk).

is clear that the typical arrangement just described would be characteristic of predominantly arable areas, but it must be remembered that large tracts of the wetter lowlands of England remained for long under damp oakwood. Probably the earliest settlements in these were mere clearings in the forest, that is, isolated homesteads. Later much of the damp oakwood became replaced by permanent pasture, and to this day in England the pastoral counties are characterised by disseminated settlements or isolated farms, whereas arable areas are characterised by the nucleated village.[1] Even when a number of the pioneer settlers were close together and formed a hamlet the population of the whole area would remain scanty and probably also poor. Not one of these hamlets or small vills would be sufficiently rich to support a church and a priest, and so in such areas of Britain as Cheshire and Shropshire, and the Marches of Wales, a church had to serve a large area of this sparsely-peopled country, and a parish came to consist of as many as 10–20 of the small vills or townships. Not infrequently these larger churches, collegiate churches as they were afterwards known, had two rectors; probably the duty of one being to tour the large parish. Such large parishes of the west seem to have been designed to provide the maximum of convenience to their population. Although they are large they are usually roughly circular or oval without awkward prolongations, and the parish church is generally to be found near the centre. On the other hand, there are large, and often irregularly shaped, parishes in the arable eastern counties due to the action of lords of the manor. Where one man held a lordship over two or three adjoining manors he tended, for the sake of economy, to combine these and to be satisfied with one church and one priest for the whole of his estate. Some of the still more irregularly shaped and unwieldy parishes owe their origin to the action of the monasteries, who endeavoured to augment their incomes from tithes by combining parishes irrespective of their boundaries, grouping them around the parish church which belonged to the monastery. This practice seems to have been prohibited in 1123, but already by that time a number of large and awkwardly shaped parishes that contradict all rational geographical principles had been formed. Each had, of course, one parish church, and the churches which had previously been parish churches, and which were still included within the boundaries, became chapels

[1] See P. W. Bryan: *Man's Adaptation of Nature.* London. University of London Press, 1932. Also E. E. Field: *Rural Settlements in Northamptonshire.* Thesis presented for the degree of Ph.D. in the University of London, 1931. (Unpublished.) But in many cases when it was supposed that the isolated homestead was the original form of settlement, the supposition has been disproved. By way of contrast for different areas see E. G. Bowen: "A Study of Rural Settlement in South-west Wales." *Geog. Teacher,* XIII, 1926; H. King: "The Geography of Settlements in South-west Lancashire." *Geography,* XIV, 1927, 193–200, and *Jour. Manchester Geog. Soc.,* XXXIX–IXL, 137–144.

or chapels of ease. Other chapels of ease were often erected in large and populous parishes.

But most of the parishes of Britain are of very ancient origin, and retained their boundaries until about a hundred years ago, when in the early part of the nineteenth century the growth of population, consequent upon the Industrial Revolution, necessitated the frequent carving up of very populous parishes into smaller units. Even this practice was not general until after the passing of an act in 1856. It should be noticed that until Tudor times the parish had been a purely ecclesiastical unit, and it was not until the decay of the manor following the Black Death and the first agrarian revolution that the parish became a civil unit. When parish councils were created by the Local Government Act of 1894, the civil parishes almost invariably coincided with the ecclesiastical parishes. County councils were given power to subdivide large parishes, and although the power was not very widely exercised,[1] where it was, the new civil parishes were made to follow the ancient boundaries of the vills or townships. This was done, for example, in Cheshire.

Returning now to the old vills or townships—these were grouped into hundreds which normally consisted of ten or twelve townships, at least in south-eastern England.[2] In the north-eastern counties of England under Danish influence larger units were formed known as wapentakes. An account of many of the old hundreds appears in the Domesday Survey. Many of them are named after spots remote from villages lying in the middle of waste land; and one may look upon such a hundred as consisting of a ring of vills or parishes having a large area of common grazing land in the middle of which was a convenient meeting place. Others take their names from larger villages which had been growing into market towns. A meeting place in the midst of waste land proved to be less convenient than a meeting place in a large village, and undoubtedly many of the old market towns originated in this way. It has been suggested that when the hundreds take their names from waste land it was a common practice for the men of the townships to meet there and sort out their cattle just as is done at the present day at the spring round-up in the great pastoral countries of the newer lands of the world. Disputes were settled by the hundred court, and hence the association of the hundred court later with market towns. The areas of the hundreds became irregular in just the same way as did the areas of the parishes, and gradually the hundred as a unit became less and less important, and local administration

[1] For although alterations were made to some 6,000 parishes, the changes were in most cases very small.

[2] Sometimes believed, at least in some cases, to have comprised roughly a hundred families.

was based on the parish and on the county. After the Napoleonic Wars problems arose which were beyond the powers of parishes to solve, and a new unit came into existence which was the Poor Law Union created by the Act of 1834. They were devised in a haphazard way regardless of geographical conditions, with the result that in less than a hundred years they have entirely disappeared. Their place has now been taken by rural districts.

The counties of England are also of very early origin. The shires practically all go back to the time of the Saxons and a large number at any rate were in existence at the time of King Alfred. The counties south of the Thames, broadly speaking, correspond to old kingdoms. Thus in the south-east of England the Anglo-Saxon Kingdom of Kent (Cantii) occupied an area roughly conterminous with Kent. It is to be observed that the areas of these old counties are natural geographical units, and their boundaries are natural geographical features. The frontiers particularly used were the sea, a river, a line of hills—such as the chalk scarp—a tract of dense almost impenetrable woodland or marshland, or an area of barren heath. Thus Kent stretched to the sea and the river on the north, to the sea on the east and to the south as far as the great impenetrable mass of woodland which then occupied the Weald. It must be remembered of these natural barriers that the woodlands have disappeared, even the areas of barren heathland have been largely utilised. Another example is afforded by Sussex, which represents the territory of downland held by the South Saxons (Regni) and which was cut off by the woodland of the Weald from the rest of England. As the woods of the Weald were gradually cleared and settled so that territory was divided between Kent and Sussex. Norfolk and Suffolk form an interesting example of a natural region, occupied in pre-Roman days by the Iceni. It was bounded by the sea on the north and on the east; by the marshland of the Fens on the west; by the thick forests, which must have covered the London Clay lowlands of Essex, on the south. The only landward entry into this region was the narrow belt of chalk downland stretching away to the south-west.[1] When the territory of the Iceni was invaded and settled by the East Anglians they found the area rather a large one and divided it into the North Folk and the South Folk—hence the modern counties of Norfolk and Suffolk.

Turning to the Midland counties of England, it must be remembered that the lowlands there were at a much later date occupied by dense damp oakwood forest which, as we have just seen, was gradually cleared and occupied by settlers, in the first instance in clearings in the forest. It would seem that the Midlands

[1] Along which was the Icknield Way (cf. Ic(k)eni Way) crossed by a succession of dykes or protective earthworks.

of England were quite arbitrarily and rather haphazardly divided into shires or counties in the tenth century in the course of the wars between Wessex and the Danes. The method followed seems to have been that certain leading settlements or military strongholds[1] were chosen as capitals of the shires, and around these were grouped such areas as at that time could conveniently be administered. Thus the Midland shires of England are not the natural geographical units that the southern and eastern counties are. One notices how

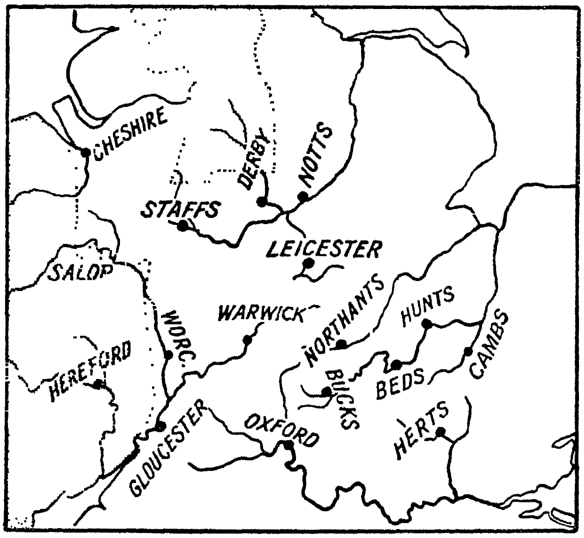


FIG. 240.—Map showing the Midland "shires" or counties of England grouped about the county town, in each case on a navigable river (*after C. B. Fawcett*).

many of these Midland shires are still named after the principal town. The very names of the old southern and eastern county kingdoms do not need the addition of the word shire, and the name of the county town often bears little or no connection with that of the name of the county, whereas in the Midlands of England we have Bedford, Bedfordshire; Northampton, Northamptonshire; Oxford, Oxfordshire; Warwick, Warwickshire; and so on. It is very interesting to notice how many of these artificially arranged Midland shires are still awkward administrative units, and present difficulties in administration even to the present day which are not found in those counties based on the natural geographical units of the old kingdoms.

Returning now to the development of settlements, we may take first of all purely rural areas: that is areas which have re-

[1] The majority on navigable rivers, emphasising the importance of river transport in lowland, still largely forested.

mained rural to the present day. If one looks upon a village as a convenient point of settlement from which the land of the surrounding vill was cultivated then one gets the idea of the primitive village as an essentially agricultural settlement. The first requirement of the people would obviously be a market centre to serve a small collection of vills, where they could exchange their commodities with one another, could sell the surplus that they had,

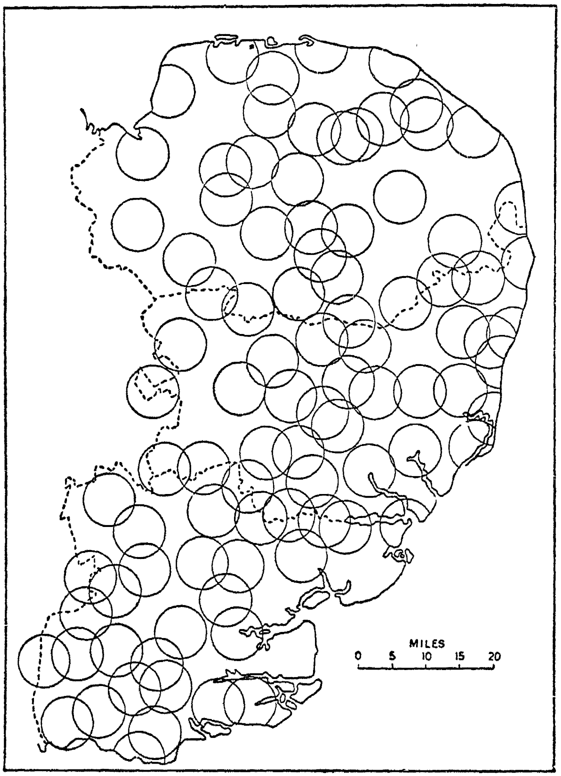


FIG. 241.—The medieval market towns of East Anglia.
Showing each with an arbitrary limit of 4 miles radius (*after R. E. Dickinson*).

and buy such of the simple necessities from the outside world as the requirements of early days demanded. But there was already an organisation which required the federation of eight or a dozen vills, and this was the hundred. So it is often the case that one of larger villages became the market town or centre of the commercial life of a hundred. It is an obvious step from this to the same town becoming the administrative centre [1] of the hundred, *e.g.* for

[1] Probably in many cases the centre was administrative first and later became a market town or commercial centre.

purposes of the administration of the law. The market towns of medieval England were closely spaced. The visit to the market town had to be made on foot, or if a carriage or other conveyance were available the condition of the tracks or roads of the countryside was so execrable that the radius served by a market town was not very appreciably increased.[1] It is clear in the more settled rural parts of England that between 7 and 10 miles was regarded as the

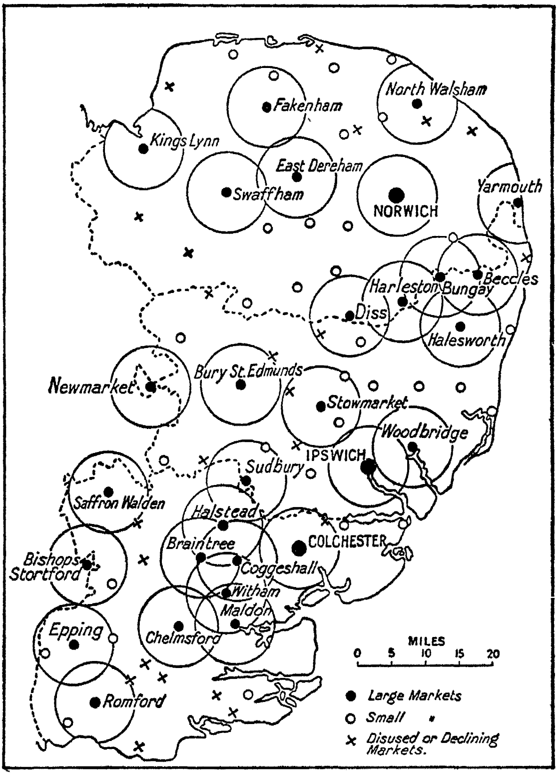


FIG. 242.—The market towns of East Anglia, about 1834.
Showing each with a limit of 6 miles radius (*after R. E. Dickinson*).

proper distance between marketing centres. Indeed, there is an old law still in existence which makes it illegal to establish a market within $6\frac{2}{3}$ miles of an existing legal market. In an interesting study of the distribution and functions of the urban settlements of East Anglia, R. E. Dickinson [2] has suggested that the maximum range of influence of the medieval market was about 6 miles, and he has

[1] But again the importance of river traffic is to be noted.

[2] *Geography*, XVII, March 1932, 19–31; see also "The Town Plans of East Anglia," *Geography*, XIX, 1934, 37–50.

drawn a map to show an arbitrary market area of 4 miles radius to each medieval town. It is remarkable how long this primitive arrangement of marketing and administrative centres remained; and it was not until about the middle of the eighteenth century that changes occurred. The gradual development of road transport after about 1780 in particular, resulted in the concentration of marketing in fewer towns due to the increased marketing radius which was possible. In the main, nodality, with ease of communications in different directions, was the factor which determined the survival of the fittest. In the early part of the nineteenth century it was possible to classify the market towns of the rural countryside into three groups: large, small, and disused or rapidly declining. This was the state of affairs in 1834 when the Poor Law Unions were brought into existence, and the market towns were constituted headquarters of the Poor Law Union districts and the seat of the Board of Guardians. But the bad designing of the unions soon became apparent; for there followed the great development in railways and the macadamisation of roads. People could easily go 8 or 10 miles to or from their market town far more easily than their forefathers two or three generations ago could travel half that distance. Roughly speaking, every alternate market town decayed, and the prosperity of the intervening ones increased. Of recent years the remaining market towns have been given what may be described as a new lease of life in that they have become the centres of the new rural districts.

The early progress of towns in what are now industrial areas was, of course, similar. Early industrialisation seems to have been fostered by one or two main causes: (*a*) the inhabitants of the town tried to utilise for some manufacture raw materials supplied to them by the visitors to the market; the rise of the woollen industry using the wool sold by local farmers is thus characteristic of Norwich and certain towns of East Anglia; (*b*) the inhabitants found that they could supply the needs of some of their neighbouring agriculturalists by goods made in their own centre. It would seem that the early trade in horseshoes and other small iron objects in Birmingham started in this way—with a supply to farmers in the local districts; the iron ore being available near at hand and charcoal for smelting it from the neighbouring forests. The cutlery industry of Sheffield may be cited as a similar instance. Natural advantages and a near-at-hand market for the produce were responsible for the inception of the industry. Thus, leaving on one side altogether the ports, a number of small manufacturing centres sprang up all over England. The Industrial Revolution and the flight of the industries to the coalfields resulted in the disappearance of many of these small industrial centres and in the immense development of others.

Here we may break off for a moment and consider what are the essential functions of a town or an urban settlement. Grouped into broad categories the functions may be described as follows :—

(*a*) Commercial.
(*b*) Administrative.
(*c*) Industrial.
(*d*) Social.
(*e*) Residential.

A study of the urban settlements of the British Isles shows that the relative importance of these functions varies from town to town. Sometimes the one may be so important as to overshadow all the others. There are reasons why the study of the functions of a town are of the utmost importance, particularly at the present day. One of these reasons is that it is perfectly clear that town planning must be varied not only according to the site which is available, but according to the functions of the town concerned. Let us attempt, therefore, to analyse in slightly more detail each function.

(*a*) *Commercial.*—This function is concerned primarily with the buying and selling of goods. The larger the town the greater the cleavage or difference between wholesale and retail. In all the larger towns there is usually a definite commercial centre. It may be represented in the large market town of a rural county by the cattle market and its surrounds—the storehouses of the corn chandlers and of the vendors of agricultural implements. In a town of a different type it is represented by the closely-spaced streets of large warehouses. But in either case the wholesale commercial centre is divorced from the retail shopping area. The growth of a town as a wholesale commercial centre depends above everything else on its nodality and its transport facilities. Under this heading comes naturally the relationship between the commercial centres of the larger towns and the railway and road systems on the one hand, and the facilities for the import of goods on the other. Thus in the larger ports we find the warehouses, representing the commercial centre, grouped near or around the docks.

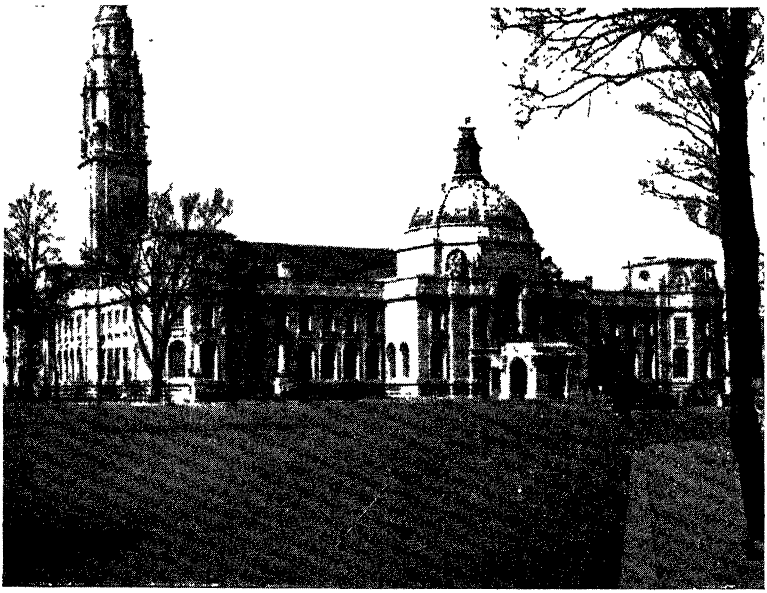
(*b*) *Administrative.*—For purposes of administration, particularly for administration applying to the whole county, undoubtedly one of the factors of greatest importance is ease of accessibility to all parts of the area concerned from the centre chosen. Quite frequently the county town has ceased to be ideal from this point of view—especially when it is essential to retain vital and immediate contact with some large centre on the borders of the county. Thus the county offices of both Lanarkshire and Dumbarton are in Glasgow. For many purposes Kingston-on-Thames and not Guildford is the county town of Surrey. Much of the business of the county of Essex is conducted from its London office.

[Photo: L. D. Stamp.

FIG. 243.—Carnarvon Castle, North Wales.

A reminder that the administrative function of an urban settlement is a very old one.

(c) *Industrial.*—It is important to realise how many of our larger towns are essentially industrial, whilst they are neither commercial nor administrative in an important sense. The reverse is also true. Manchester and Leeds are primarily the commercial and to some extent administrative centres, as well as in some degree social centres, of a manufacturing area in each case, rather than being primarily industrial. We have considered elsewhere in this book the requirements of industrial centres, and these points need not be reiterated : but just as the commercial and the administrative offices of a large town are frequently collected to-



[*Photo : L. D. Stamp.*

FIG. 244.—One of the buildings of Cardiff's civic centre.

Cardiff is the outstanding example of a city which has deliberately planned a great state and civic centre—with the City Hall, County Offices, University College, National Museum of Wales, War Memorial, and other buildings, all of [illegible]

gether in definite areas, so also—even more markedly—are the industrial works. Provided the essential requirements of easy receipt of raw material and easy despatch of finished articles are satisfied then the town planner can do much to direct industrial development round an existing town in those ways which will best serve the whole community.

(d) *Social.*—The social functions of an urban settlement are not always fully realised or given their proper importance. Women form more than half the population of the British Isles, and it is calculated that over three-quarters of the money passed over

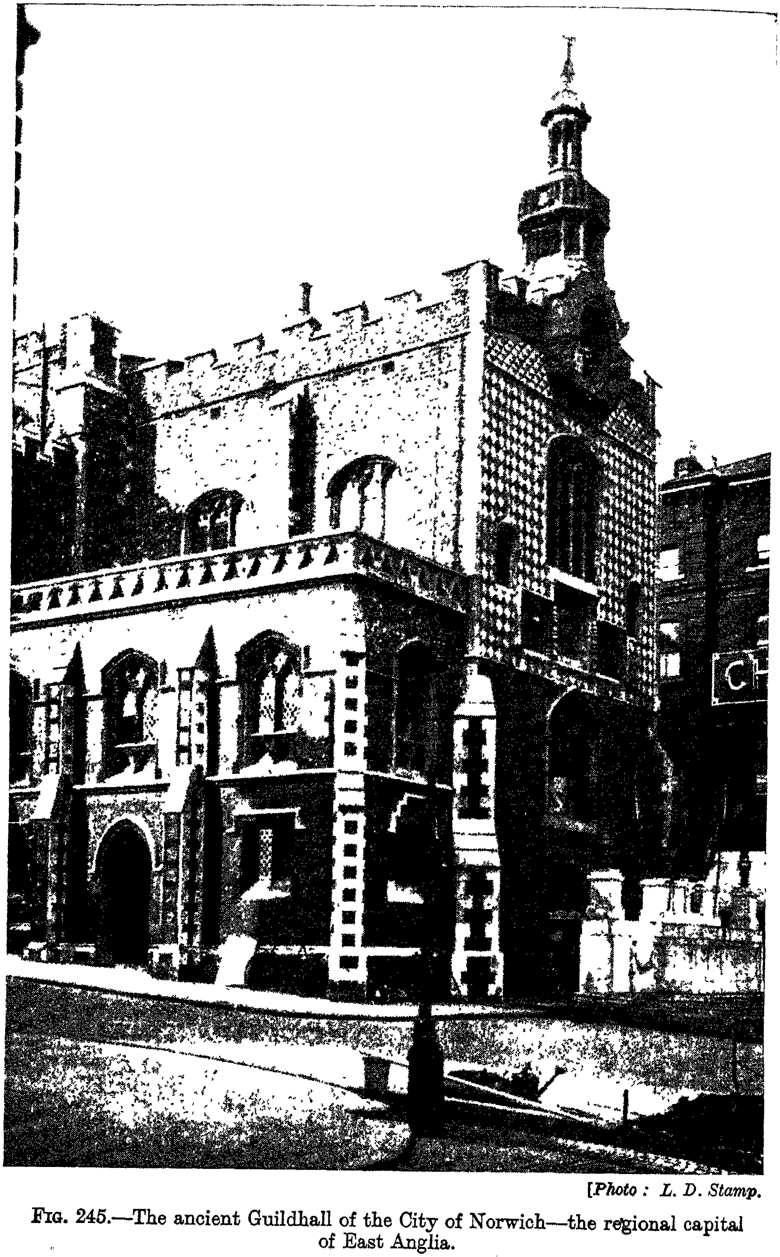
counters in retail stores is passed over by women. In other words, women do the shopping. Yet how many women pay a visit to a town with the purely utilitarian motive of shopping and nothing else ? This question might have a double question mark after it. For is it not true to say that the choice of the town and the choice of the route is not infrequently determined by (*a*) the attractive nature of the displays in the shop windows ; (*b*) the possibility of a lunch in a pleasant restaurant with music, and (*c*) a visit to a cinema where light and life—real and unreal—afford a relaxation from the daily round and common task ? In the larger towns or for longer journeys, such as a trip to London, there may be the added attraction of the theatre. The hotel and the club must be near at hand. It is particularly in the evening that the town exercises its social influence over men and women together. This conjunction of the social services is of the utmost importance, because in town planning one cannot divorce the shopping centre from the centres of amusement such as we have described. What is the quintessence of the importance of the West End of London and of other cities which boast a West End ? Or of Broadway and Fifth Avenue in New York ? In certain towns another factor of importance comes in and that is the influence of the church. No one who has lived in a smaller cathedral city can fail to appreciate the importance of this factor and its influence. In some areas schools and colleges exert a somewhat comparable influence. It is often forgotten that there are large numbers of towns in the British Isles where the social influence is paramount, and where the fostering of the social influences becomes the main industry of the town. This is, of course, the case with seaside resorts and with inland spas. With all her richness in scenic beauty and historic remains Britain has not realised the full possibilities of what has now come to be called the tourist traffic. For example, how many British seaside resorts have so far developed their attractions in the winter months that one may unhesitatingly go for a week-end being assured of a lively and sustained period of relaxation from daily business ? Here the modern generation, not unreasonably, demands things on a large and lavish scale. Nothing could be more miserable than the seaside resort with three-quarters, perhaps all, of its places of amusement closed for the winter ; and nothing could be more attractive than a fine pavilion—well lit, with music, food, and a view of the sea—in the winter months.[1]

[1] A number of the larger towns of Britain have scarcely been mentioned in this book. They have little or no concern with industry, they are not ports nor commercial nor administrative centres. Many of them will be found to include the essentially social-residential cities and towns. A leading member is Bournemouth—the youngest large town in Britain ; others include Harrogate, Bath, Buxton (spas) ; Scarborough, Cromer, Margate, Eastbourne, Torquay, Newquay, Llandudno, Blackpool, and Douglas (I. of Man) (seaside resorts). A study of their evolution has recently been made by E. W. Gilbert, *Scot. Geog. Mag.*, LV 1939, 16–35.

(e) *Residential.*—There are some towns which are mainly residential. They are either dormitories for the large cities such, for example, as many of the smaller towns in a ring round London, or they may be the residential town for an industrial area, as Newcastle-under-Lyme is for the smoky Pottery towns of the North Staffordshire coalfield. But a fact, again too often forgotten at the present day, is that there are very few areas which can be purely residential in this sense. They must either have absolutely first-class facilities for communication with the larger centres, or they must develop their own social life. Expensive housing estate schemes and garden city suburb schemes have proved failures for this very reason; and here arises a big question which the Britisher has not yet decided. His choice at present is between the semi-detached villa with the little strip of garden where he may amuse himself in the evenings, but from which he has to face daily his half-hour's or his hour's journey to and from his business, and the flat in a block of luxury flats in a large building where he has at hand the social attractions of the city, including the public parks with their beds of flowers, probably so superior to anything that he could have produced in his own little garden had he been a dweller in the suburbs.

This disquisition on the functions of urban settlements has been rather a lengthy one; but it is a subject to which more and more thought ought to be given in England. For a true interpretation of trends is a necessary prelude to a successful planning for the future.

It is true that a town or city in the fullest sense of the term has all its functions fully developed. A few years ago Professor C. B. Fawcett, in a suggestive little book, outlined a scheme for the division of England and Wales into provinces, each province, of course, with a provincial capital. It is clear that he had in mind the necessity of a provincial capital having fully developed all the functions above outlined for towns. Although it is unlikely that England will ever be divided into provinces in this way, there are in existence a number of towns or cities which do fulfil the functions of a provincial or a regional capital. A good example is afforded by Norwich, the regional capital of East Anglia. Centrally situated on the East Anglian plateau, it is even so a port. Its large cattle, sheep, and pig markets point it out as the natural capital of a predominantly agricultural area; and it is, of course, the administrative centre of the large county of Norfolk. It has developed manufactures of two main types: the food industries utilising the produce of the farmers of the region; and side by side with them the manufacture of agricultural implements and such things as wire netting which are required in quantity by a farming community. In other cases its industries have undergone an interesting process



[*Photo : L. D. Stamp.*

FIG. 245.—The ancient Guildhall of the City of Norwich—the regional capital of East Anglia.

Built of the traditional local materials—faced flints.

of evolution. When the woollen and worsted industries departed to the coalfields, manufacture of boots and shoes—of recent years fancy shoes for women's use—was deliberately introduced. The totality of its civic and religious life, the intense local patriotism, the extent and variety of its shopping centres, and its amusement facilities leave no doubt as to the importance of the city as a social centre.

Taking another example, it is possible to find two towns which may be roughly the same as regards size, yet may be very different in function. It would be wrong to use the word important, and to say that one is more " important " than the other. For who shall judge that the commercial and administrative functions are of necessity more important than the manufacturing or *vice versa* ? An interesting study of a pair of towns of this character has been carried out by R. E. Dickinson.[1]

It is appropriate to mention here another aspect of the geography of towns and cities. Four-fifths of the people of England and Wales and Scotland live in towns and cities, and indeed a considerable proportion of the remainder may be described as living in settle-

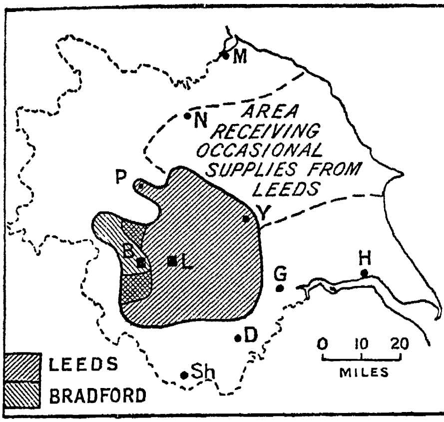


FIG. 246.—The zones of influence of Leeds and Bradford as distributing centres.

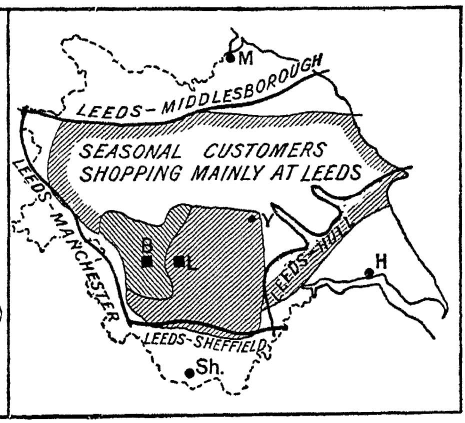


FIG. 247.—The zones of influence of Leeds and Bradford as market or shopping centres.

The heavy lines mark [illegible] or time by train of the two [illegible] case.

ments of too great a size to be considered as villages. Thus the immediate environment of more than 80 per cent. of the people of

[1] " The Regional Functions and Zones of Influence of Leeds and Bradford." *Geography,* XV, 1930, 548–57. Here Leeds is the regional capital, Bradford the great manufacturing city. See also British Association, Leeds Meeting, 1927, *General Handbook,* edited by C. B. Fawcett. Steadily increasing attention has been paid in recent years to the control of urban development by town planning. The Town and Country Regional Planning Acts vest many powers in the Ministry of Health and development is permitted according to a predetermined " zoning " into industrial and housing areas, the latter of different degrees of density. Special interest attaches to the planned garden-city of the type of Welwyn and Letchworth, the planned colliery villages of the Doncaster coalfield and the extensive " industrial estates " such as Trafford Park and Wythenshaw (Manchester), and Speke (Liverpool). On the other hand public attention is now directed to the need of preserving the best of Britain's countryside and of Britain's historical buildings—hence the activities of the Council for the Preservation of Rural England and 15 sister bodies; and of land for public recreation—hence the activities of the National Trust, the " Green Belt " scheme for London and the agitation for a system of National Parks.

this country is an urban environment,[1] and it has rightly been pointed out that geographers concentrate too much on the reaction between man and a rural environment where the physical elements are more directly apparent or more directly operative. One particular aspect of environmental influence is that which has been studied by Dr. P. W. Bryan, and which he has termed, following some American writers, the "cultural" aspect. Whatever the natural environment, man with his tillage or his buildings alters it: the natural landscape becomes the cultural landscape. The life of man becomes influenced not only by the natural factors of his environment, but also by those features which he has himself created.

The significance of the urban environment becomes greater when one considers the actual distribution of the urban population. This has been studied by Professor C. B. Fawcett with reference to the censuses of 1921 and 1931, and many points of interest are contained in his paper read to the Royal Geographical Society in December, 1931.[2] He points out that the census figures often give a quite inadequate measure of the relative size and importance of the larger centres of population because the figures refer to the areas defined by local government boundaries. Actually the densely-populated areas are contiguous and form continuous urban areas. One of the best known examples of this, of course, is that of Manchester and Salford. Thus the term conurbation—suggested by the late Sir Patrick Geddes—has come to be widely adopted. Professor Fawcett defines a "conurbation" as "an area occupied by a continuous series of dwellings, factories, and other buildings, harbours, and docks, urban parks and playing fields, etc., which are not separated from each other by rural land; though in many cases in this country such an urban area includes enclaves of rural land which is still in agricultural occupation." On this basis there are no less than seven such conurbations in Great Britain, each of which contains more than a million people; and there are also thirty others with more than 100,000 people. It is found that 40 per cent. of the total population of Britain is living in the seven "million cities" or conurbations—that is half the total urban population. The

[1] In his study of East Anglia, quoted above, Dr. R. E. Dickinson has distinguished all settlements of over 1,000 people as towns or urban settlements, and he has classified them into four groups: (1) fully fledged towns—with large markets, all the essential retail services, three or more banks, a cinema, a newspaper, secondary school, and usually some local industries. Most towns of this character are recording increases in population. (2) Towns of 1,500–4,000 inhabitants with most of the essential services, but with small or decayed markets and which are showing a decline in population. These are the towns which have been superseded by the larger towns and suffer from competition as the result of railway and road transport. (3) Towns with large live-stock markets, but which have not yet social services. They have from 1,000–2,000 inhabitants and are tending to increase in size. (4) Lowest grades with population of 1,000–2,000 and which may have banks and the usual retail services, but none of the social services.

[2] *Geographical Journal*, LXXIX, 1932, pp. 100–116.

position of these conurbations is shown on the accompanying map (Fig. 248). The seven major ones are as follows :—

(1) London—with an aggregate population of about 10 million and to which separate consideration is given below.

(2) Manchester—with the continuous urban area of Manchester and Salford in the centre, and six smaller urban districts closely joined therewith, thus giving an inner ring with more than 1 million inhabitants. Round this, at a distance of from 12 to 18 miles from the central point, is what may be called the Manchester ring: the towns of Salford, Bury, Rochdale, Oldham, Stockport, etc., all being linked to the central core by regular bands of urban character. The total population is $2\frac{1}{2}$ millions.

(3) Birmingham. This is the well-known Black Country, of which the city of Birmingham contains about half the total urban population.

(4) The West Yorkshire conurbation, of which Leeds and Bradford are the two largest members, and which includes most of the woollen towns of the West Yorkshire coalfield.

(5) Glasgow and the lower part of the Clyde valley. The city itself contains just over a million inhabitants, and is by far the largest part of the conurbation.

(6) Merseyside—including Liverpool, with two-thirds of the total population, and Birkenhead and Wallasey on the opposite side of the Mersey.

(7) Tyneside, of which the natural centre—Newcastle—contains about a quarter of the total population.

The other major centres are shown on the map.

The Industrial Regions of Britain.—In a previous chapter we have considered the agricultural regions of Great Britain, and it has already been noted that many of the market towns within those regions developed, for various reasons, manufacturing industries. Leaving on one side the ports and the regions accessible from the coast, we have noticed that the early industries tended to be either those using the local raw materials of agricultural origin or industries which were primarily concerned with supplying the urgent needs of the rural population of the neighbourhood, though which in turn tended to depend upon readily available supplies of local raw materials. We have seen also that the coming of the Industrial Revolution entirely altered the distribution of population in Britain. There has thus arisen in Britain another series of regions—the great industrial regions—which can be looked on as superimposed upon the agricultural regions and to a large extent independent of them.

In this book we have considered each of the leading industries of the British Isles separately and not according to the industrial regions. The reader will find a recent account of the regional geography of Britain in that valuable volume edited by Professor

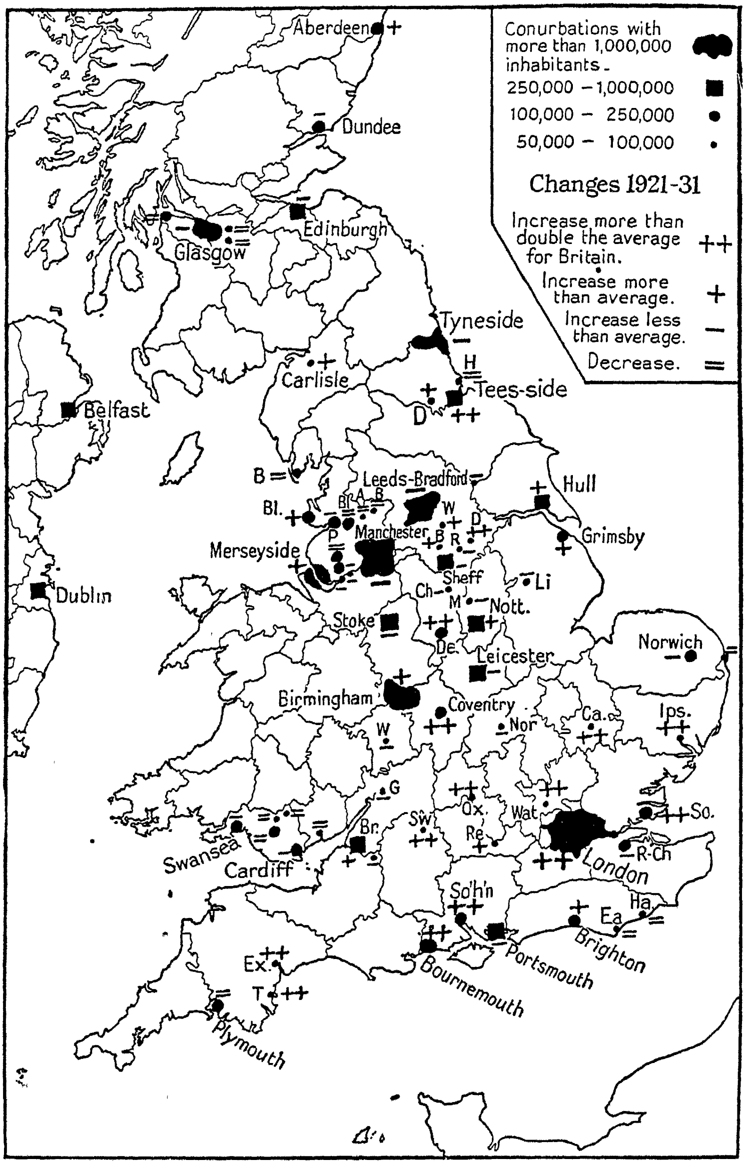


FIG. 248.—The larger towns of Britain (all with more than 50,000 inhabitants are marked), and their population changes, 1921–31.

This map illustrates the effect of industrial depression in Lancashire, South Wales and Scotland.

The large decreases of the seaside resorts are mainly due to the fact that the 1921 census was taken in June, that of 1931 in April.

A. G. Ogilvie, entitled "Great Britain: Essays in Regional Geography."[1] Most of the larger industrial regions have also been investigated recently by the Universities of the country at the request of the Board of Trade, and a series of "Industrial Surveys" has been published. In order to facilitate the work of those who may be interested in one particular area the following list of the leading industrial regions has been drawn up, with references to the part of this book in which each has been considered :—

I. *North-Eastern England or Northumbria (including Tees-side and Tees-mouth).*
For association with coal mining, see pp. 286–90; development of iron and steel industries and shipbuilding, pp. 356, 386; glass, chemical, and smelting industries, pp. 439, 523.
See also *An Industrial Survey of the North-east Coast Area* made for the Board of Trade by Armstrong College, Newcastle-upon-Tyne, H.M.S.O., 1932; also Ll. Rodwell Jones: *North England,* Chapter II, and A. J. Sargent: "The Tyne," *Geog. Journ.*, 1912.

II. *The North-western Industrial Area.*
For the coalfield, see pp. 290–1; development of iron and steel industry, pp. 339–41, 357–8.
See also *An Industrial Survey of Cumberland and Furness,* by J. Jukes and A. Winterbottom. Manchester University Press, 1933, and *West Cumberland,* by G. H. J. Daysh, 1938.

III. *The Industrial Region of Lancashire and North Cheshire.*
For the coalfield, see pp. 292–4; the rise and decline of the woollen industry, pp. 449, 467; the cotton industry, pp. 473–87, 493–6; the mid-Mersey industrial region, pp. 439, 522; the industrial development associated with Liverpool, pp. 439, 639, and Manchester, pp. 403, 493, 646.
See also *An Industrial Survey of the Lancashire Area.* H.M.S.O., 1932, *An Industrial Survey of Merseyside.* H.M.S.O., 1932.

IV. *The Potteries.*
See pp. 294–5 and pp. 531–2.

V. *The West Yorkshire or West Riding Region.*
For the coalfield, see pp. 296–301; rise of the woollen industry, pp. 449–52, 461–7; associated industries, pp. 404, 438, 538.

VI. *The South Yorkshire or Sheffield Region.*
For the coalfield, see pp. 296–301; rise of the iron and steel and associated industries, pp. 364–6, 405, 437.

VII. *The Nottingham area.*
For the coalfield, see pp. 296–301; the textile industries, pp. 502–5; other industries, pp. 405, 539.

VIII. *The Leicester Area.*
See pp. 301, 408, 505.

IX. *The Warwickshire Region.*
For the coalfield, see p. 302; the engineering industries, pp. 401, 408.

X. *Birmingham and the Black Country.*
See pp. 303, 361–3, 407, 438, 540.

XI. *South Wales.*
For the coalfield, see pp. 304–7; the iron and steel and associated industries, pp. 358–61, 375–80, 439.
See also *An Industrial Survey of South Wales* made for the Board of Trade by University College of South Wales and Monmouthshire. H.M.S.O., 1932, and *The Second Industrial Survey of South Wales,* H. A. Marquand. III vols. Cardiff, 1937. Also S. W. Rider and A. E. Trueman, *South Wales.* Methuen, 1929.

XII. *London and the South-east.*
See Chapter XXVIII. Also pp. 388, 438, 515.

XIII. *The Midland Valley of Scotland.*
For the general character of the region, see pp. 30–31; the coalfields, pp. 309–312; heavy industries, pp. 353–6, 406; textile industries, pp. 487–9.
See also *An Industrial Survey of South-west Scotland* made for the Board of Trade by the University of Glasgow. H.M.S.O., 1932.

[1] Cambridge University Press, 2nd Edition, 1930.

CHAPTER XXVII

THE GROWTH OF COMMUNICATIONS[1]

THE history of the development of facilities for communication in the old-established and highly industrialised country of Britain is a subject so vast, and withal so well supplied with literature,[2] that in this chapter, fascinating though excursions into economic history might prove to be, we can scarcely hope to present more than a brief essay in the geography of transport, and an analysis of the relative importance of geographical and other factors in influencing the growth of roads, canals, and railways.

Two features of fundamental importance have played a part in modelling our present transport system. In the first place, one may say that Britain is, on the whole, by its physical nature, well favoured for the development of two out of the three major modes of communication—road and rail. There exist very few real barriers to road construction in the shape of high mountain ranges or wide marshes, and the " negative " areas are of such small extent that both roads and railways can round the obstacles without long détours. The all-important raw materials, both for road making and for the road beds of railways are widely distributed (cf. p. 325), and railways are, in addition, favoured by the existence of fuel supplies of excellent quality—a fact which has had no little influence on British locomotive design and practice. For canals, however, the undulating surface of Britain, with its industrial regions separated for the most part by upstanding areas of harder rock or by alternating scarps and dip-slopes, is not nearly so well adapted as, for example, the flat plains of the Netherlands and North Germany; whilst long navigable rivers free from vexatious sinuosities are non-existent. Although Britain passed through a canal era of great importance in its industrial development, it is not surprising that this form of transport should have seriously declined with the rapid expansion of railways.

Secondly, a characteristic feature of the development in Britain

[1] By S. H. Beaver. For valued comments on this chapter the authors are indebted to Mr. W. T. Stephenson, Cassel Reader in Transport in the University of London at the London School of Economics, and to Mr. C. E. R. Sherrington, Secretary of the Railway Research Service.

[2] Standard works are Jackman: *Development of Transportation in Modern England*, 2 vols., 1916 (a solid and well documented piece of research) and Pratt: *History of Inland Transport and Communication in England*, 1912 (a more popular and more readable account).

of railways, canals and the "turnpike" roads, has been the dominance of private enterprise, and the virtual absence, from the Roman period until quite recently, of government assistance.[1] This strict adherence to laissez-faire principles, with its preservation at all costs of open competition, lest a dreaded "monopoly" should come into being, has been responsible for many of the difficulties of the present transport system, and for many of the differences which exist between Britain and Continental countries. There has been no national plan, as in the case of the railways and "routes nationales" of France; instead, the systems grew during periods of boom—the canal "mania" of the 1790's and the railway "mania" of 1845–47—in a haphazard fashion, without any sound geographical basis or real economic need. Turnpike trusts were established in large numbers in many parts of the country, with little reference to the economic needs of the period; canals—long since derelict—were constructed through areas where neither through nor local traffic could reasonably be expected to yield a profit. Some of the early railway lines were similar; others were constructed merely to act as competitors to already existing lines.

With these preliminary considerations in mind, we may attempt very briefly to trace the history of transportation in this country.

The Roman roads, military in origin and well planned and constructed, were for the most part stone causeways, following a straight course from beacon to beacon across the higher and more open ground above the forests and marshes of the lowlands.[2] Even at this early stage the importance of London as a focal point was well marked (cf. Fig. 228). For a long period after the departure of the Romans little attention was paid to communications, and although many improvements were made in the thirteenth and fourteenth centuries conditions of transport subsequently deteriorated considerably. Rivers were undoubtedly more important than roads, and nearly every town of any size was a river port (*e.g.* York, Lincoln, Gloucester, Chester) (cf. Fig. 240). The accessibility of the university towns of Oxford and Cambridge was certainly improved by the waterways of the Thames and Cam. Towns such as Birmingham and Bradford, not on navigable streams, were non-existent or of no consequence.[3] The medieval roads were mere trackways, the actual route of which was constantly shifting to avoid the more dilapidated patches.[4] There was but a meagre demand for intercommunication between towns and villages

[1] Note, however, the military roads of the Scottish Highlands, constructed in the eighteenth century by General Wade and his successors, and the costly but rather useless Caledonian and Crinan Canals built with government money.

[2] See Ordnance Survey Map of Roman Britain.

[3] Birmingham remains an example of one of the very few large towns in the world actually on or near a water-parting.

[4] This continual departure from a direct course may possibly explain some of the curious sinuosities in the present day roads.

when subsistence agriculture and domestic industry were the rule, and the upkeep of the roads was regarded as a charitable occupation and so left mainly to the monks. With the breakdown of the manorial system, the decline of the fairs and the cessation of pilgrimages, and, finally, the dissolution of the monasteries, the roads grew worse and worse. An act passed in 1555 delegated the labour of road mending to the parishes. This measure actually remained in force until 1835, but it really cannot be said to have succeeded in greatly improving the road system, for the statutory parish labour was easily evaded and the methods employed were of the most primitive order. There was still no pressing need for efficient roads until the trade of the country, both internal and external, began to expand in Elizabethan times. The fairly late introduction of industry into Britain, when compared with certain parts of the Continent, is largely due, in fact, to the difficulties of internal transport.

The increase of wheeled traffic played havoc with the layers of mud and stones which passed as roads in the seventeenth century. Long covered wagons had begun to be used in the sixteenth century, and stage coaches made their appearance fairly early in the seventeenth century, and the result was a series of regulations concerning weights to be carried and width of wheels, it being thought that wide rims would cut up the roads less than narrow ones. The legislation, it should be noted, was concerned with adapting the vehicles to the roads, not with improving the roads to accommodate the vehicles. Descriptions of roads and journeys during this century and a half (1600–1760) are numerous and entertaining. The "Tours" of Defoe[1] and Young have been previously referred to in this book. It was indeed an adventure almost equivalent to a modern crossing of Central Africa to undertake a long journey through Britain, and it is little wonder that those who performed such travels wrote at great length of their experiences. The many clay belts of England were areas of especial difficulty. In the winter the roads across these regions were almost impassable, and the sparse settlements were isolated for months on end. Of particular ill-fame were the roads across the Weald Clays of Sussex, across the London Clay, Gault, and Oxford Clay belts which intervene between London and the Midlands, and across the bogs of South Lancashire. Heavy lumbering carts with their numerous horses cut the roads into deep ruts, and the laying of stones only served to make progress more dangerous and uncomfortable for travellers on horseback or in wheeled vehicles. Of the road to Wigan, Arthur Young says: "I know not in the whole range of language terms sufficiently expressive to describe this infernal road . . . eighteen miles of execrable memory." Obviously industrial development was not aided by such conditions, and South

[1] See especially Appendix to Vol. II of Defoe's *Tour thro' the island of Great Britain* (original edition, 1724–26).

Lancashire and the Birmingham region, especially, found themselves hampered by the difficulty of disposing of their goods. Road speeds, too, were extremely slow. In the middle of the eighteenth century, Edinburgh was 10 to 12 days' coach journey from London, Exeter 4 days, Birmingham and Dover 2 days, and so on. It was with the object of improving road conditions that the Turnpike Trusts were set up. The first of these was instituted in 1663 on a section of the Great North Road in the clay belt between Hertfordshire and Huntingdon; their object was to obtain money for maintaining the roads in good condition by charging tolls. About 1,100 separate trusts were formed, the greatest period being 1760–1775; but many of them controlled only a few miles of road, and large numbers were thoroughly inefficient, most of the tolls going towards the payment of trustees' salaries. There is no doubt, however, that the turnpike movement did an enormous amount of good for road transport, especially after the advent of new methods of road making. Until the beginning of the nineteenth century the construction of roads was not regarded as an occupation worthy of the skill of engineers and, as we have seen, the authorities tried in vain to adapt the traffic to their poor surfaces. Between 1810 and 1820, however, two men, Telford and McAdam, began to apply scientific principles to road building; Telford, who commenced reconstructing the Holyhead road in 1815, concentrating upon the creation of a solid foundation and adequate draining; McAdam, who attained the position of "Surveyor-General of Roads" in 1827, devoting his attention to the production of the durable impermeable surface which still bears his name.[1] A great impetus was thus given in the 'twenties and 'thirties to the development of coaching traffic. Just when the Turnpike Trusts were beginning to set the roads of Britain in good order a new form of transport, the railway, entered the field and deprived them of much of their revenue. During the second half of the century they were all wound up, the control of the roads passing into the hands of Parish Councils and Highway Boards, and later into those of the reconstituted Local Government bodies, County, Borough, Urban and Rural District Councils; and road transport for several decades became a matter of local importance, until the evolution of the petrol motor rendered the construction and maintenance of roads of first class national significance.

The age of bad roads, in the seventeenth and eighteenth centuries, is marked by an increased attention to river navigation.

[1] The essential point of his work was the discovery that stone broken to a uniform size and of angular shape could be made to bind together. The tarring of the pieces (and the making of tar-macadam) with the consequent elimination of dust, is largely a post-War development, which has given Britain the finest system of roads in the world. The reinforced concrete road has gone still further to solve the problems of roadmaking in country with a soft subsoil.

The natural waterways had been for so long neglected that their beds had become silted up, and disastrous floods occurred after periods of heavy rainfall. Thus, many medieval ports, such as Lewes, Ely, Bawtry, York, and Doncaster, had been deprived of their position and had lost in trade and importance thereby. The first Act for improving a river was actually passed in 1424 concerning the River Lea (an important highway for London's wheat supply), but the great age of dredging and artificial cutting (to avoid the frequent meanders) was between 1660 and the beginning of the canal era. Although rivers all over the country were subjected to much improvement, the greatest incentive came from the north of England where industries were beginning to develop rapidly. Thus the Mersey was improved as far as Warrington in the 1690's, and in 1720 three new projects were sanctioned—the Mersey and Irwell navigation, giving navigable water as far as the growing town of Manchester; the Weaver navigation, opening up the Cheshire salt-field, and the Douglas navigation, providing an outlet for the Wigan coalfield to Preston. The Aire and Calder navigation, commenced in 1699, stimulated the growth of Leeds and Hull, and the improvement of the Don enabled the manufacturers of Sheffield to obtain an easier outlet for their valuable produce.

The various disabilities attaching to river navigation, however, such as time wasted in following the innumerable windings, the difficulty of towing upstream, and the fluctuation in depth of water according to season, together with the fact that several growing industrial areas, such as Birmingham and the Potteries, were not served by navigable rivers, led to the development of artificial waterways or canals. The link between the two is the Sankey Canal, sanctioned in 1755, as a river improvement scheme to provide an outlet for the Wigan coalfield. The improvement of the Sankey Brook being found impracticable, an entirely artificial cut was made. From this small beginning an extensive canal system came into being within the next 60 years. The canals were built by private enterprise, competing with the Turnpikes, and the companies were modelled on the lines of the Trusts, that is, they were toll-takers, and not carriers. As a result, there was great variation in depth and width, size of locks and gauge of tunnels, etc., and through long distance traffic was compelled to pass over the property of several different companies.[1] At first, however, the improvement in speed upon road transport, the reduction of freight rates to about a third or a quarter of the amounts charged on the roads, and the ability of the canals to carry bulky raw materials and finished goods in hitherto inconceivable quantities sufficed to enable many of the canals to pay enormous dividends.

[1] *E.g.* Birmingham to Liverpool, six canal companies, each canal of different dimensions; Liverpool to Hull, ten companies.

Geographical influences in the growth of the principal elements in the canal system—if it can be called a system—are very evident. The increasing use of coal in industry and as a household fuel, together with the industrial development of the Midlands and North, where the roads were particularly bad, were responsible for the greater part of the canal cutting taking place in those areas, whilst the south was left—with one or two exceptions—comparatively untouched. The Black Country, South Lancashire, and the West Riding became the principal foci, London, with its river navigation and coasting trade, being distinctly ex-centric in marked contrast to its position as regards the roads and later railway nets. In Lancashire and Yorkshire three needs were being catered for: (*a*) more adequate disposal of coal; (*b*) easier transport between the cotton and woollen centres and the coast; (*c*) coast to coast communication, in order to avoid long coastal voyages. Thus, the Worsley Canal linked the Duke of Bridgewater's collieries with Manchester, the Bridgewater Canal gave the cotton capital a new and better outlet to the Mersey estuary, and the Leeds and Liverpool Canal, and also the Rochdale and the Huddersfield canals, linked the navigable waters on either side of the Pennines. The Leeds and Liverpool Canal, especially, was responsible for much new industrial development in the Aire valley and in the valleys north of Rossendale Forest. The great canals of the Midlands fall into two groups. In the first place there is the complicated system in the Birmingham-Black Country region, which afforded much-needed outlets for coal and the bulky produce of the iron and other metal industries; secondly, there are the canals designed to link up the major navigable rivers. Of these the most important were the Grand Trunk from Trent to Mersey, which had a truly remarkable effect upon the development of the Potteries, where Wedgwood had just recently (1763) begun his improvement of the staple industry (cf. p. 531); the Shropshire Union, linking the Birmingham system with the Mersey; the Grand Junction, giving navigable water from London to Birmingham and the Trent; the Thames-Severn (across the Cotswolds to Stroud) and the Kennet-Avon. These inter-riverine canals were instrumental in displacing a great amount of coastal sailing; when coasting steamers developed they lost most of their traffic, and the last two, for example, are now disused. South Wales also developed canals as an aid to its coal export trade —the Monmouthshire and Glamorganshire valleys providing obvious lines of movement to the ports of Newport and Cardiff. It is noteworthy, however, that Northumberland and Durham —the home of wooden and iron tramways (*vide* Chapter XV and *infra*) never adopted a canal system. In Scotland [1] the Forth and Clyde Canal from Bowling to Grangemouth had as its primary

[1] E. A. Pratt: *Scottish Canals and Waterways*, 1922.

object the connection of the coasting trades of east and west Scotland [1]; but the Monkland Canal (from Coatbridge to the Forth and Clyde Canal at Glasgow) and the Union Canal (from the same canal at Falkirk to Edinburgh) were both constructed to give outlets for the Lanarkshire coalfield. The state-aided Caledonian and Crinan Canals (the former from Fort William to Inverness and the latter across the head of Kintyre) have never been of any real economic importance.[2]

The great boom in canal construction came between 1791 and 1794, during which period 81 new canal and navigation Acts were passed. Many of these were for quite useless canals which either soon went out of business or became absorbed in the larger concerns. The coming of the railway after 1830 was the beginning of the end for a large part of the canal system. In that year the British Isles possessed 4,270 miles of canals and inland navigations (*i.e.* improved rivers), over 3,200 in England and Wales, nearly 200 in Scotland and nearly 850 in Ireland. By reason of the great industrial expansion of Britain, traffic on many of the canals actually increased until the end of the century, but the total canal traffic was very small beside that carried by the railways.[3] We may profitably summarise the principal reasons why the decline of the canals has taken place and why their resuscitation is impossible.[4]

(1) The narrow canals and rivers of Britain are ill adapted for speedy carriage, for fast moving vessels create a wash which would quickly undermine the banks. On a number of canals mechanical propulsion is actually prohibited, only horse towage being allowed. On the other hand, on the Grand Union system concrete banks are being provided to enable faster motor boats to operate.

(2) Britain, we have said, is not physically suited to canals. Locks are required in great number and tunnels (many of them without towing paths) are not infrequent, and the resultant delays add considerably to all journey times. Between London and Avonmouth, for example, in 178 miles, there are 125 locks (including a remarkable " staircase " of 29 at Devizes); between Liverpool and Hull, 159 miles, there are 147 (92 in 32 miles over the summit of the Rochdale Canal); between London and

[1] Its western terminus was ten miles below Glasgow, owing to the shallowness of the Clyde.

[2] Even modern pleasure steamers start from above the famous "Neptune's staircase" of locks at the southern end of the Caledonian Canal.

[3] 1898: Canal traffic 39 million tons; railway traffic 379 million tons. These are " unreal " figures, since traffic passing from one company to another was recorded by each company and so may figure several times in the total. However, the truth of the generalisation made above is apparent.

[4] See Royal Commission on Canals and Inland Navigation, Cd. 4979, 1909, also E. A. Pratt, *Canals and Traders*, which sets out clearly the arguments against the revival scheme proposed by the Commission.

Birmingham *via* Blisworth, 159 locks in 135 miles; and between Birmingham and Sharpness 62 locks in 75 miles. At Anderton (near Northwich) a hydraulic lift raises barges 50 feet from the River Weaver navigation to the Trent and Mersey Canal.

(3) A large part of the canal system is of small dimensions, incapable of taking boats drawing more than 4 feet of water, or more than 7 feet in width. Narrow canals are especially characteristic of the Birmingham system, on which special narrow barges must be employed.[1] The impossibility of widening these canals is evident when it is realised that over much of their extent in the Black Country the banks of the waterways are completely built over with factories, works, and even dwellings, many of which, though possibly owing their site to the facilities for water transport, now make little use of them.

(4) Many canals, designed to facilitate coal transport, pass through coal mining areas in which ground subsidence is of frequent occurrence, and the maintenance of the waterway consequently difficult. Thus, in the Black Country, in Lancashire, and in Derbyshire, subsidence has occurred to such an extent that the canals now run in places above the general level of the land, like an embanked river over its flood-plain.

(5) Canals which cross watersheds are likely to experience difficulty in obtaining adequate water supply. Were such canals to be enlarged, great reservoirs would need to be constructed in order to render navigable the deeper and wider channels.

(6) Turning from the physical to the economic side, we find that the great disadvantage of the canal is its lack of flexibility and its capacity for serving adequately only those factories, mines, and farms which lie along its banks. Owing to the initial cost and difficulty of construction, a canal is very much less flexible than a railway. Canals, moreover, are not well adapted for carrying small loads to a number of different points. The railway, with its 12-ton trucks, possesses here a distinct advantage over the 50-ton barges of the waterway. A characteristic feature of modern commerce is the forwarding of small parcels at frequent intervals; for such traffic the canal cannot compete with rail and road.

(7) A certain part of the canal system began to decline during the second half of the last century through falling into the hands of the railways. The railways, for the most part, were not anxious to purchase the canals; they were almost forced to do so, since the canal companies, seeing their traffic dwindling, threatened to set up competitive rail lines, and the railway companies in self-defence bought them out. Thus, in 1845 the Birmingham Canal Company threatened to build a new

[1] It is not the open channels of the canals which are narrow, but the locks and bridges, which it would be very difficult and costly to widen.

railway parallel to the London and North Western line, and so the Railway company (now part of the L.M.S.) took over the management and guaranteed the shareholders an annual dividend of 4 per cent.—which is still paid. Some of the railway-owned canals still carry a fair amount of traffic—for the railways are under obligation to maintain their waterways in navigable condition—but others are slowly dropping out of use.

(8) The British canal system is hampered by multiplicity of ownership, already referred to.[1]

(9) A last disadvantage of canals in Britain is the comparatively short haulages which can be performed. No industrial town of moment is more than 80 miles from a seaport, and so much of the traffic which is suitable for water-carriage is taken by coasting steamers.

In spite of all these disabilities, however, and in spite of the indispensable service which the railways and roads are able to offer, waterways have still an important contribution to make to industrial development, and when their facilities are available alongside other means of transport and in a district convenient for distribution there are positive advantages offered to certain industries, as, for example, coal and china-clay. Fig. 249 shows the navigable waterways existing in 1928. Apart from the lower reaches of the Thames, Severn, Humber, Mersey, Tees, and Tyne, the principal canals and navigations are the following: Grand Union (for local London traffic and through traffic London to Birmingham, Leicester, and Nottingham), Shropshire Union (carrying much traffic between the Black Country and the Mersey), Trent and Mersey (Potteries to Mersey section only), Leeds and Liverpool (chiefly on the Lancashire side), the Birmingham system (mainly local traffic), the Aire and Calder Navigation (giving long haulages, comparatively free from locks, between the West Riding and Goole), the river Trent below Nottingham (much improved within the last decade), the Birmingham and Wolverhampton-Bristol Channel connections, and, of course, the Manchester Ship Canal. Many formerly important rivers now carry little or no traffic (*e.g.* the Dee, Idle, Nene, Welland, Bedford Ouse, Yorkshire Ouse above York, Witham, Wharfe, and Wye), and the " navigations " of the Fen country (the main object of which is drainage) are almost disused. The only important navigable waterway in East Anglia is the river Yare from Norwich to Yarmouth.

Just as the canal system owed its origin to the growing dissatisfaction with the bad roads of the eighteenth century, so a

[1] A notable scheme of amalgamation came to fruition in 1930, with the formation of the Grand Union Canal Co., uniting the Grand Junction with the Regents Canal (London) and six others in the south-east Midlands. This 300-mile waterway has been improved to accommodate 100-ton barges.

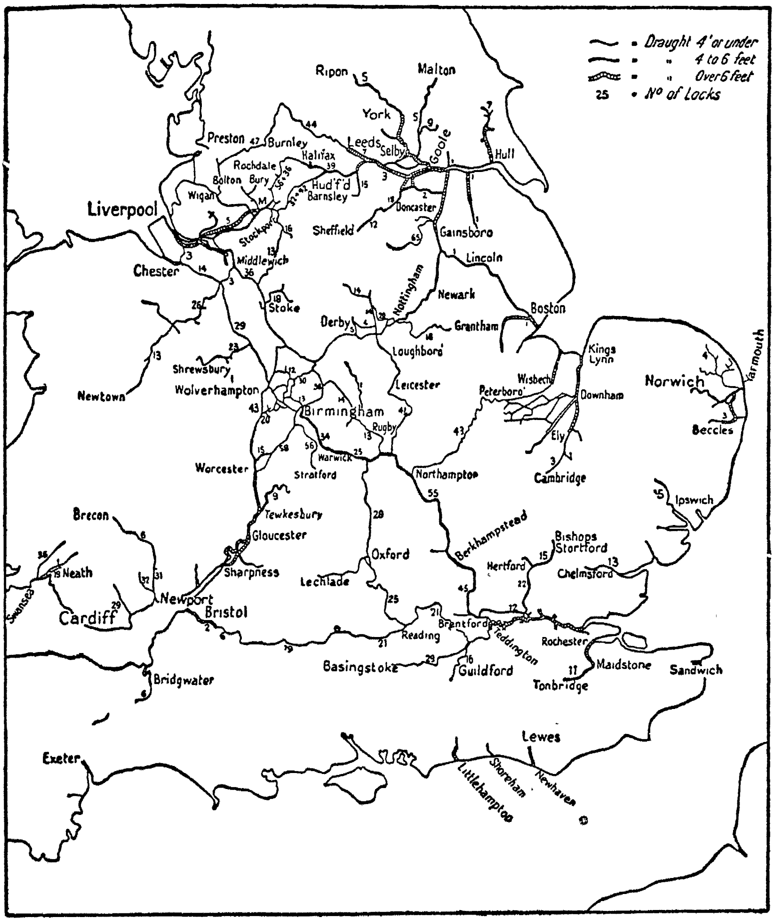


FIG. 249.—Navigable waterways of England and Wales, 1937.

Scale 66 miles = 1 inch.

Beyond the northern limit of this map are the rivers Tees and Tyne. The Tees is navigable (draught over 6 feet) for 19 miles below Yarm; the Tyne for 19 miles (draught over 6 feet) below Ryton.

NOTE.—The above map does not indicate the importance of coastwise traffic, the significance of which may be gauged from the table on p. 625.

large part of the railway system grew up in the first place to supplement the inadequate services provided by the waterways, and to introduce better transport into those areas where canals had not penetrated. Again, too, we find that private enterprise was responsible, and the result was a haphazard growth almost completely devoid of plan or any suggestion of a possible national system. Parliament, moreover, did all it could to promote competition and prevent any line from having a monopoly of traffic. Railways in Britain were regarded as dangerous innovations, to be resisted alike by turnpike trusts, canals, and landowners, and the result was that from their very beginning they were hampered by excessive costs—heavy legal expenses in order to overcome opposition to the passing of their bills, and exorbitant charges for land.[1] To a certain extent the initial over-capitalisation thus entailed has been a burden to the railways ever since.[2] The origin of the railways, like the canals, as mere toll-takers, is probably responsible also for the present situation as regards wagons; the smooth working of goods traffic is considerably hampered by the existence of thousands of privately owned wagons—actually about 600,000 out of a total of 1,500,000—for which a free empty journey must be allowed for every loaded trip.

To an even greater extent than that of the canals, the early history of the railways is bound up with the coal trade. Long before the invention of the locomotive, wooden, and later iron, tramways had been utilised in the Northumberland coalfield for transporting coal from the mines to Tyneside (cf. Fig. 148), and similar systems arose in Shropshire and in South Wales. The Tyne had for centuries been an avenue for coal traffic, and the increasing distance of the collieries from the river was not easily bridgeable by canals, owing to the nature of the land surface. In South Wales, too, away from the main valley bottoms, canals were virtually impossible, and thus an extensive system of tramways grew up around Merthyr Tydfil and between that town and Cardiff. Between 1801 and 1825, when the first real "railway" was opened, no less than 29 "iron railways" were constructed in various parts of the country, mostly connected with canals, iron-works or collieries.

The influence of the coal trade upon the early railway system may be gauged from Fig. 250.[3] The Stockton and Darlington line, the first public railway, was intended to provide an outlet for coal from Witton Park to the Tees, and its promoters had no intention of carrying passengers. A network of lines quickly developed

[1] The London and Birmingham, for example, paid £72,868 in legal costs, and an average of £6,300 per mile for land. See Pratt: *History of Inland Transport*, Chapter XX. Also H. G. Lewin: *The Railway Mania and its Aftermath*. London, 1936.

[2] It must be remembered, however, that these high costs really ceased before half the mileage was constructed, and the present high capitalisation is as much due to subsequent expenditure upon widening the lines to meet traffic growth.

[3] See H. G. Lewin: *The British Railway System* (to 1844). 2nd Edition, 1925.

in the north-eastern area, linking the collieries with the mouth of the Tyne and with the ports of Sunderland, Hartlepool, Stockton, and Port Clarence. In the Scottish lowlands the earliest lines (Monkland and Kirkintilloch; Glasgow and Garnkirk) were built to connect the Lanarkshire coalfield with the Forth and Clyde canal and with the port of Glasgow; in South Wales the Llanelly railway and the Taff Vale lines were likewise developed to facilitate coal movement; and the Leicester and Swannington line was designed to carry coal from the Leicestershire coalfield to the county town at a cheaper rate than that charged by the Soar navigation from Derbyshire. In Lancashire the inability of the existing system of waterways to accommodate the vastly increased traffic between Liverpool and Manchester engendered by the cotton industry was mainly responsible for the step taken by a group of merchants in promoting the Liverpool and Manchester railway, opened in 1830, but several subsequent lines had as their main object the improvement of the coal trade (*e.g.* the Wigan Branch railway).

In the 'forties the nucleus of the present Midland railway began to appear. This series of lines (Midland Counties, Rugby-Leicester-Derby; North Midland, Derby-Chesterfield-Leeds; Derby and Birmingham junction) had as its main object the improvement of Derbyshire coal trade—and it is interesting to note in this connection the way in which the subsequent Midland Railway, with the same intention, extended long tentacles to all parts of the country, its powers extending as far as Yarmouth, York, Carlisle, Liverpool, Bristol, Bournemouth, Swansea, and Southend.

Many of the early railways, as we have seen, were primarily coal carriers; passenger transport was a subsidiary business. It soon became apparent, however, that except in the colliery districts of Northumberland and Durham, Lanarkshire, South Wales, and South Lancashire—all of which were close to navigable water—the canals still held a great advantage in cheapness of conveyance, and that the railways would derive far greater benefit from the carriage of human freight. The second great object of the railway promoters was thus to link up the existing large centres of population with each other and with London, an object which, as Fig. 250 shows, was in an advanced stage of progress before the "mania" years. By 1844 through communication was established between London and Folkestone, Brighton, Southampton, Exeter, Bristol, Manchester, Liverpool, Preston, Birmingham, York, Leeds, and Newcastle; and the future importance of Birmingham and Manchester as junctions was foreshadowed. No less than three trans-Pennine connections were complete. The absence of the Great Northern line from these maps is an interesting reflection of the nature of the country through which that line afterwards passed—

an extensive agricultural tract where there was little possibility of large local traffic.

The bulk of the mileage, then, until the "mania" years of 1845–47, was dependent mainly upon passenger traffic for its revenue.[1] By this time the energy of the canal companies in trying to retain their traffic was beginning to wane, and from thenceforward goods traffic began to play an increasing part in the economy of the railways.

The subsequent history of the railway system is largely a story of development in hitherto neglected areas, and of amalgamations to form the great companies which existed before the grouping of 1921. We may profitably observe some of the geographical and economic consequences of that development. In the first

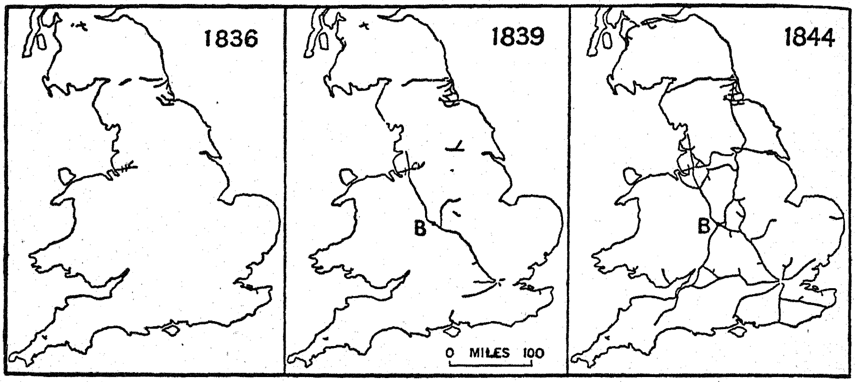


FIG. 250.—The growth of the British railway network.

B = Birmingham. The two curious outlying lines, Bodmin—Wadebridge (Cornwall) and Canterbury—Whitstable (Kent) are interesting. The former was constructed to carry shelly sand from the Camel estuary to the agricultural lands around Bodmin; the latter to carry coal to Canterbury owing to the silting of the river Stour.

place, the railways stimulated the growth of population and industries at their terminals and crossing points. Folkestone was the first railway-created port, but numerous others—*e.g.* Grimsby, Immingham, Middlesbrough, Fleetwood, Southampton, and the South Wales ports—have been largely developed, if not actually created, by the forerunners of the railway companies which at present own them. There are many examples, too, of towns which grew up at railway junctions. The outstanding examples are Crewe and Swindon (see Fig. 251). At Crewe, before the coming

[1] To such an extent had the early objective of coal carrying been forgotten by some of the passenger lines that the following remark is probably representative of the more aristocratic attitude towards railways: "Coal!" a certain Mr. B. of the London and Birmingham is reported to have exclaimed, when it was first suggested that his railway should carry so humble a commodity—"why, they'll be asking us to carry dung next!" (Acworth: *Railways of England,* p. 153.)

of the railway, not even a village existed ; and the original Swindon was a tiny village on the top of an outlier of Portland stone over a mile south of the railway junction which lay in the clay vale beneath. In both these cases the growth has been aided by the development of railway works. Ashford (Kent), Bletchley, and Rugby are other examples. At the crossing of rail and river, the railway frequently gave a new lease of life to the decayed river ports—*e.g.* Lincoln, Gloucester, Chester, and Selby.

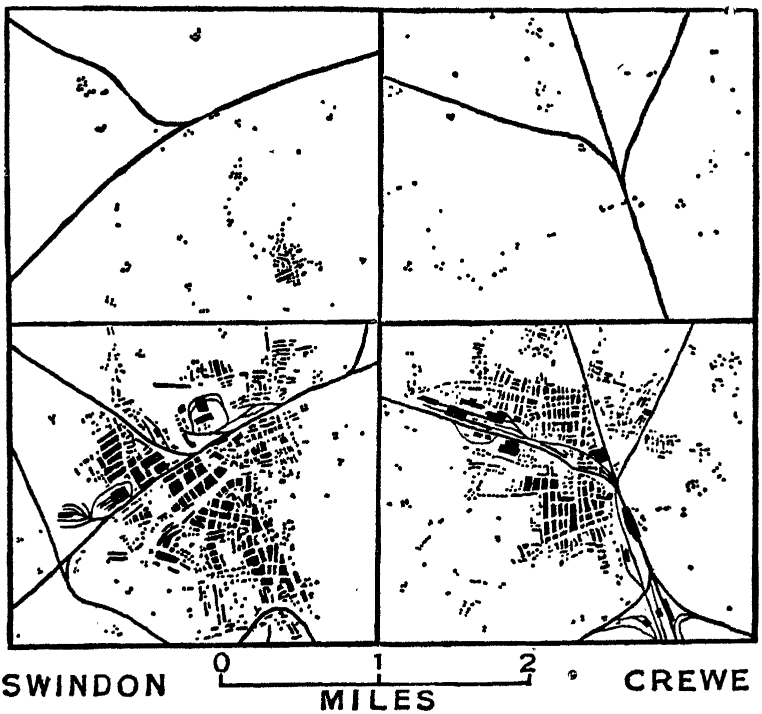


FIG. 251.—Two railway created towns—Swindon and Crewe.

The two upper maps show railways and buildings in the early 'forties; the two lower maps show the same features at the present day. In each case notice the railway works.

The power of the railway to attract commerce and industry was so obvious that towns which had not yet been reached pressed for new lines, lest their development should be arrested. Not only did the railways help to concentrate industry on the coalfields by transporting raw materials to the fuel supply, but, by working in the opposite direction, they allowed the survival and renewed development of old industries in localities far removed from coal

—as, for example, the engineering industries of the eastern counties. With the declining dominance of the coalfields as iron-producers the railways have also contributed to the scattering of industry over the countryside. In the development of the great conurbations the railways have been of prime importance. The vast daily movement of passenger and goods traffic in these thickly populated areas would be impossible without the railway. The railway web of a conurbation is well worth examining. It consists essentially of radial lines with belt connections. The most symmetrical example is Paris, but London and Manchester (Figs. 252

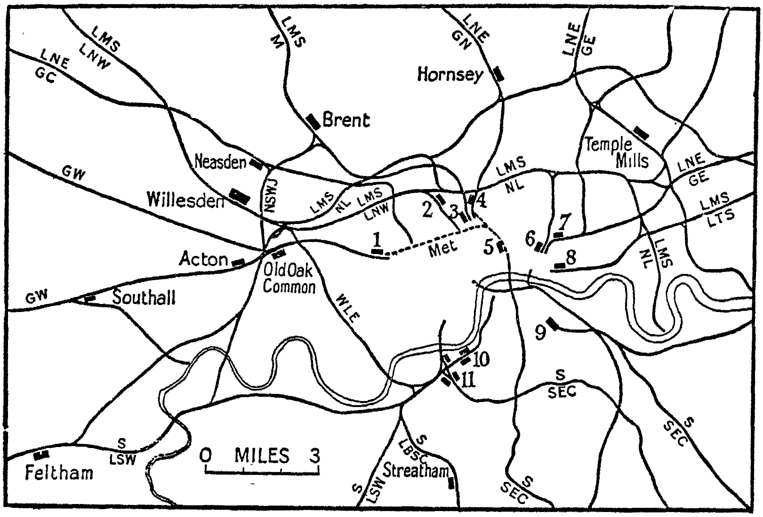


FIG. 252.—The radial lines and belt connections of London.

The principal marshalling sidings are named. The terminal goods depots are numbered: 1, Paddington; 2, Camden; 3. Somers Town; 4. King's Cross; 5, Farringdon; 6, Broad St.; 7, Bishopsgate; 8, Fenchurch St. 9, Bricklayers Arms and Willow Walk· 10, Nine Elms (north and south); 11, Battersea (S.R., G.W.R., and L.M.S.R.).

and 253) may be taken as equally representative. In the case of London, the radial web is particularly well developed; but it is noteworthy that the belt connections are mainly situated on the north and north-west sides—for the obvious reason that most of the traffic arrives from the Midlands and north. The function of the North London line, from Acton and Willesden to Camden, Broad Street, and the Docks; of the North and South-west Junction line, from Cricklewood (Brent sidings) *via* Neasden and Willesden to the London and South-western line, and of the West London Extension railway, linking Willesden and Old Oak Common with the great Southern Railway depôts at Battersea, should be specially

noted. The distribution of the goods depôts is also interesting. These are of two kinds—the terminals, where the traffic is transferred to the markets or to road vans for distribution, and the concentration sidings in the suburbs near the belt lines. Fig. 253 shows that the same general plan can be detected in the case of Manchester—although here, as might be expected, the belt lines are mainly on the south and east (*i.e.* on the side of the great industrial regions of the Midlands and Yorkshire).

The part played by the railways in the development of holiday resorts has been of immense value both to the favoured towns and

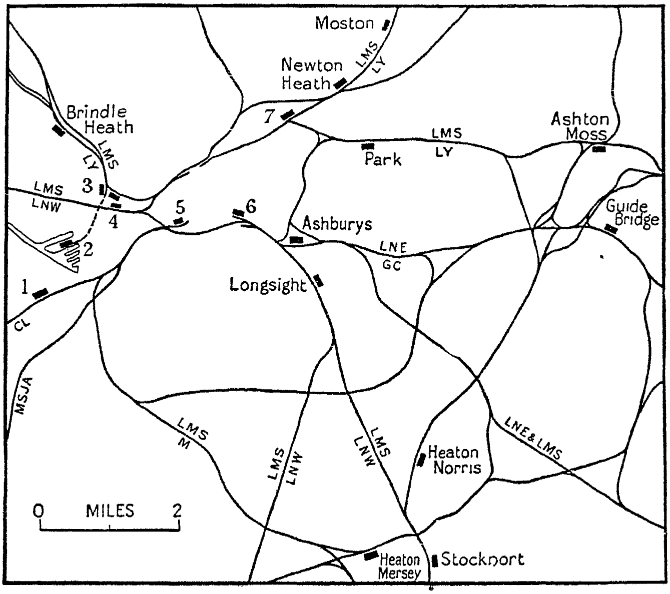


FIG. 253.—The radial lines and belt connections of Manchester.

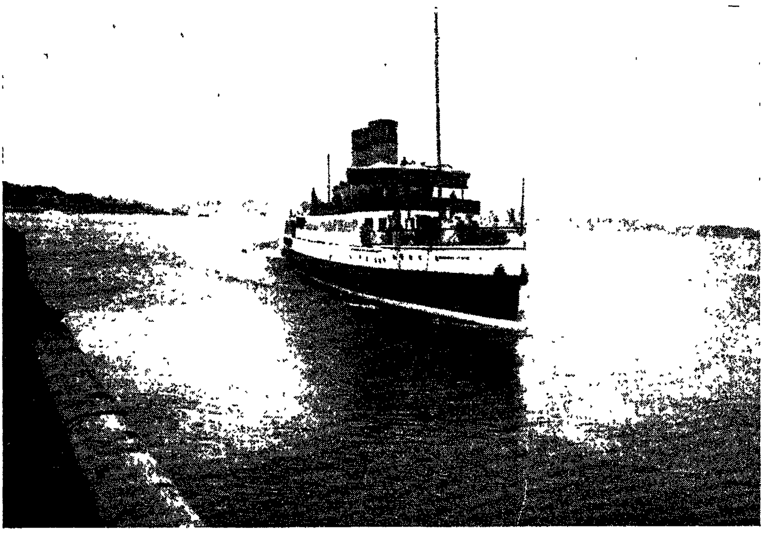
It is not possible to make the same distinction between suburban marshalling sidings and terminal goods depôts as in London. Nos. 2, 5 and 6 most nearly resemble the London terminal depôts. Key to numbers: 1, Trafford Park; 2, Salford Docks; 3, Hope St. and Windsor Bridge; 4, Liverpool Road; 5, Deansgate; 6, London Road; 7, Oldham Road.

to the people who are thus enabled to visit them. Many a West of England fishing village was given a new lease of life by rail-borne holiday traffic, and a number of the foremost resorts, for example Bournemouth, Cleethorpes, Blackpool, and Clacton, were almost non-existent before the coming of the railways.

Lastly, the railways have frequently chosen somewhat barren and thinly populated sites for the establishment of huge concentrating sidings where the traffic from many areas can be re-sorted and distributed. Such are Toton, on the edge of the formerly flooded Trent lowland between Derby and Nottingham (where

of three main lines of traffic on the old L.N.W.R. (cf. Fig. 251), and Stoke Gifford, which collects Bristol and South Wales traffic on the G.W.R.

Two of the outstanding features of the British railway system are the perfection of its permanent way (and consequent reputation for speed) and the small size, when compared with the Continent or the United States, of its rolling-stock. The former is largely due to the way in which the lines were originally built. In the first place, solidarity of construction was a policy carried to extreme degrees in order to satisfy those who feared for the safety of the



[*Photo: L. D. Stamp.*

FIG. 255.—A L.M.S. mail steamer approaching Dunoon.

In western Scotland steamship services play a very important part in communications. Dunoon is the county town of Argyllshire—the second county of Scotland in order of size. It is 28 miles from Glasgow as the crow flies, about 30 by steamer, but 80 by road (involving some stiff hills) and has no railway.

trains; secondly, the early engineers were for the most part haunted by a fear that the locomotive would only run on level or nearly level lines, hence the extraordinary care taken, by the provision of deep cuttings and tunnels and lofty embankments, to ensure the gentleness of the gradients.[1] The "toy railways" of Britain are due primarily to the adoption of a small loading gauge (*i.e.* width and height of carriages and engines allowed) in the early days—from our pioneer experience of which continental builders profited by employing a larger one—but full development under such conditions would have been difficult but for our excellent

[1] See S. H. Beaver, "Geography from a Railway Train," *Geography*, XXI, 1936. 265–83.

coal supplies. With fuel of high calorific value small fire-boxes and boilers can be employed on the locomotives; the engines of many Continental and American railways, burning inferior fuel or even lignite or wood, must needs have the ungainly heat-raising apparatus which makes them such monsters when compared with our own.

It remains in this chapter to call attention to the most recent trends of transport. The coming of the automobile has created a new interest in our roads, and the development of by-passes and arterial highways is proceeding apace in many parts of the country, particularly around the larger centres of population. The rapid increase in commercial road transport is presenting the railways with a problem which is still in course of solution. In 1935, according to the report of the Traffic Commissioners, the roads carried just over 25 per cent. of all the goods traffic of the country, and the railways just under 75 per cent. In the same year about 40 per cent. of all the work of carrying passengers was performed on the roads and 60 per cent. on the railways.

Civil aviation, largely perhaps owing to the comparatively small distances which can be covered in Britain, and to the necessity for auxiliary and time-wasting road services at the terminal cities connecting the landing ground with the business centre, has not yet reached a stage of development comparable with that, for example, of the United States. It is true that air-ports have sprung up close to many of the principal towns, but air traffic cannot yet be said to have been popularised in this country for internal communications though a considerable organisation of Empire airways has been built up, based especially on Southampton and now under the British Overseas Airways Corporation. Moreover, no national plan for a network of services seems to have been developed, and private enterprise imperfectly co-ordinated is characterising the spread of airways just as it characterised the growth of the turnpikes, canals, and railways.

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CHAPTER XXVIII

LONDON [1]

What is London ? Before attempting any description of London and its activities, it is necessary to attempt to define what the name "London" connotes. For at least half a dozen different boundaries are in common use, each enclosing a tract which, for specific purposes, is considered as "London." These are the City of London, the County of London, the Metropolitan Police area, or Greater London, the London Postal area, the London Telephone area, and the London Traffic area. To avoid confusion, therefore, it seems desirable to define as briefly as possible the different areas commonly called London.

The smallest unit which may be designated "London" is the City of London, commonly called the City, and which coincides roughly with Roman London or with medieval walled London. The City is only a little over a square mile in area (678 acres) and, lying wholly to the north of the river, includes the two hills separated by the long since obscured Walbrook. To the west the City extends beyond the medieval Lud Gate and the valley, where once the Hol-bourne flowed into its estuary the "Fleet," as far as Temple Bar. Here, until 1878, a bar in the form of an archway across Fleet Street actually existed to mark the limit of the City of London, and at this point it is still the custom of the Lord Mayor to present the sword of the City to the ruling sovereign on his entry. The City is still the hub about which the great wheel revolves. London is a world exchange for almost every commodity, and as such may still be said to merit the proud title of the commercial capital of the world. The City is still the heart of this commercial London, but it no longer has the monopoly that it had even until a few years ago. For every important business house in the world has offices or representatives in London and, since the London City subsoil is at least one factor rendering difficult the building of skyscrapers, commercial London has had to expand laterally and is rapidly invading the formerly residential or "social" areas of Westminster and the West End. Great office buildings of the post-war period, such as Bush House, are outside the City, whilst the still newer

[1] The authors are indebted for criticisms and suggestions on this chapter to their colleague, Dr. H. R. Ormsby and also to Mr. M. I. Michaels, Assistant Secretary of the New Survey of London Life and Labour.

Thames House and Imperial Chemical Building are even further west than the Houses of Parliament. But the City still has within its bounds the Bank of England (" The Old Lady of Threadneedle Street "—recently rebuilt from within with the exterior unaltered), the Stock Exchange, and the great commodity exchanges as well as the world-famous insurance corporation of Lloyds, the ancient Guildhall, and the official residence of the Lord Mayor (the Mansion House). The ever increasing pressure on space required for office accommodation has naturally resulted in a steadily decreasing residential population. Compared with 128,129 in 1801, at present fewer than 11,000 live in the City, but nearly half a million come in daily to work in its offices. The deserted City on a Sunday morning is a sight not to be forgotten.

The County of London comprises the City of London, Westminster (created a " city " in 1900) and 27 metropolitan boroughs. The four boroughs of Stepney, Poplar, Shoreditch and Bethnal Green lying to the east of the City coincide roughly with what is popularly designated the " East End." The " East End " is still essentially industrial, and some of the leading industries will be noted later, whilst the southern parts, Stepney and Poplar, include some of the docks of the Port of London. Several of its outstanding features —its rows of small, too frequently squalid, houses, its innumerable little shops—the East End shares with the majority of industrial towns, but the large alien population is a distinctive feature. Whitechapel, lying within this area is popularly, and largely correctly, associated with London's Jewish population ; Limehouse with London's " China Town." To the immediate west of the City of London is the City of Westminster. Less than 200 years ago it was still a pleasant walk through the fields from London to Westminster, but it has long since been impossible to the ordinary Londoner to distinguish where one begins and the other ends. In Westminster are the Houses of Parliament and that street of government buildings, Whitehall with its famous, if insignificant, offshoot Downing Street. Westminster merges into and in many respects is part of the " West End." Here the fashionable residential area clings round the parks and squares, whilst London's great shopping centres lie along the main thoroughfares. But great blocks of flats are rapidly replacing ducal mansions, shops are invading the quiet residential squares, office buildings are replacing hotels. The West End includes also that curious enclave of somewhat squalid streets, famous for its varied foreign population and its restaurants, known as Soho—a local industrial area largely dependent on the main shopping centres near. The West End is ill-defined and merges outwards on the west and north into the upper-class residential areas. The East End, the City, and the adjacent boroughs of Holborn and Finsbury, and the West End may be regarded as

constituting central London, but to the north and west, within the county, there lies a large area, partly residential, partly industrial (the boroughs of Paddington, Marylebone, Hampstead, St. Pancras, Islington, Stoke Newington, Hackney, Chelsea, Fulham, and Hammersmith). That part of London lying south of the Thames is largely industrial and commercial in its inner ring, and residential towards its outer margins.

Greater London comprises the City, the County, and an "outer ring" which lies in the administrative areas of the counties of Middle-

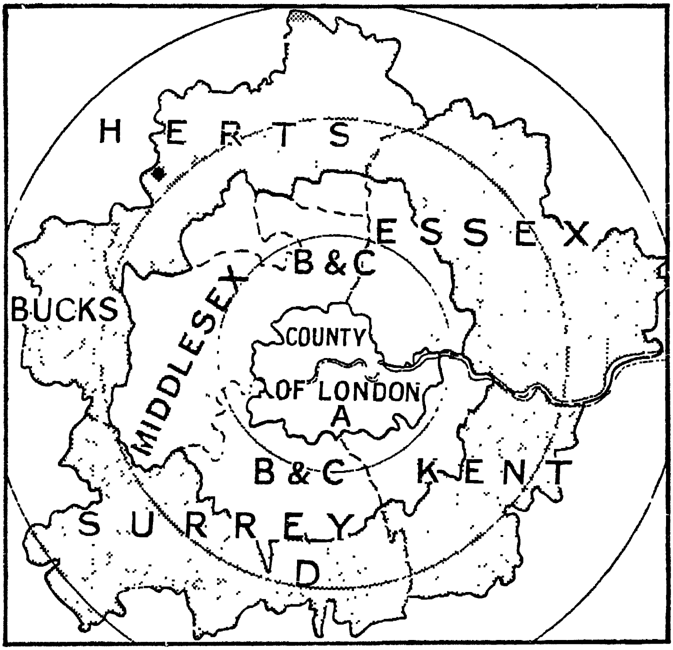


Fig. 256.—London.

A = the county of London; B and C = the outer ring, making up "Greater London"; D = the outermost ring making up, as a whole, the London traffic area or the area considered by the Greater London Regional Planning Committee. The circles are described with radii of ten, twenty, and thirty miles from the Bank of England.

sex, Hertfordshire, Essex, Kent, and Surrey. Precision is, however, given to the term when it is defined as the Metropolitan Police area. The census figures of 1921 and 1931 for "Greater London" refer to this area, and its extent is shown in the accompanying figure. The outer ring coincides with what may be roughly termed the "suburbs" or the outer suburbs. Taking the outer ring as a whole, it may be described as London's dormitory, and a very large proportion of those who live therein journey daily to some point within the administrative County of London to earn their daily

bread. But there are included within this outer ring areas of a different character :—

(a) Some tracts of the outer ring which are administratively outside the County of London are really an integral part of

FIG. 257.—The administrative divisions of Greater London, 1937.

Epsom and Ewell, Bexley, and Wembley were made boroughs in 1937.

London proper. Thus, the largest of London's docks lie in West Ham and East Ham, and the industrial district of the East End merges insensibly into West Ham, East Ham, Barking, and, more recently, Dagenham. Similarly, on the south side the Erith industrial area is a continuation of that of Woolwich.

(b) On the other hand, some centres in the outer ring retain an entity of their own as local centres—for example, Croydon and Epsom.

(*c*) In other tracts, notably in the north-west sector and especially along the main Great Western Railway line through Slough, new industrial centres are springing up and expanding rapidly in the heart of the outer ring.

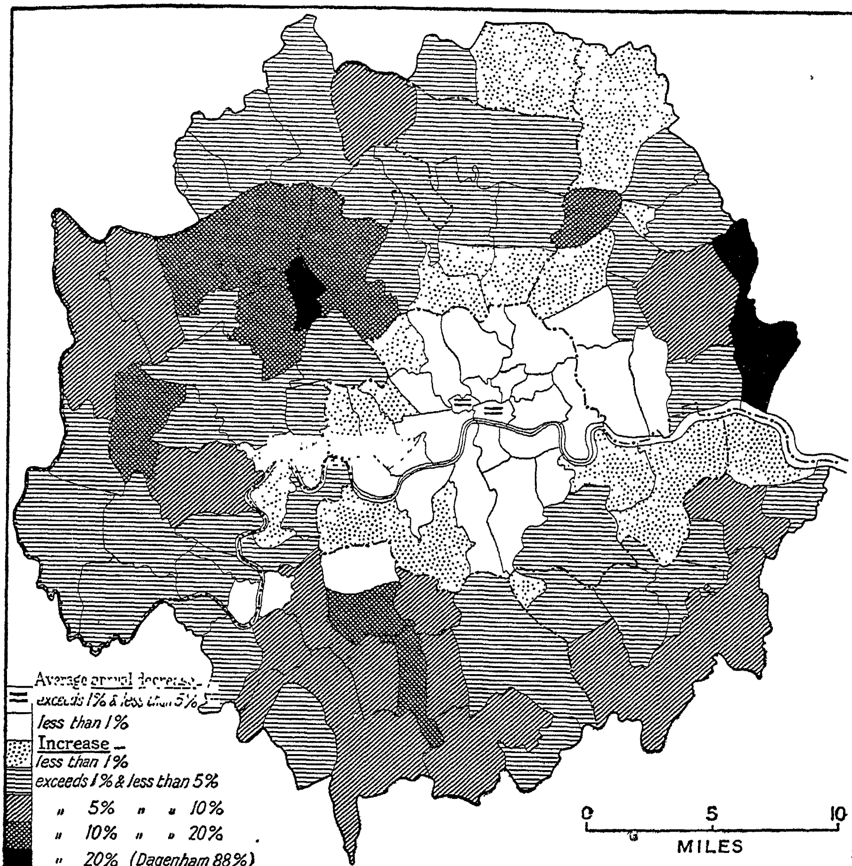


FIG. 258.—Population changes, 1921–31, in the administrative divisions of Greater London.

Showing the decreasing population of the county or inner ring and the increasing populations of the outer ring.

Greater London in another sense (as used, for example, by the Greater London Regional Planning Committee [1]) embraces an even larger area stretching almost to the crest of the chalk hills on the north and even beyond them on the south, and is thus equivalent

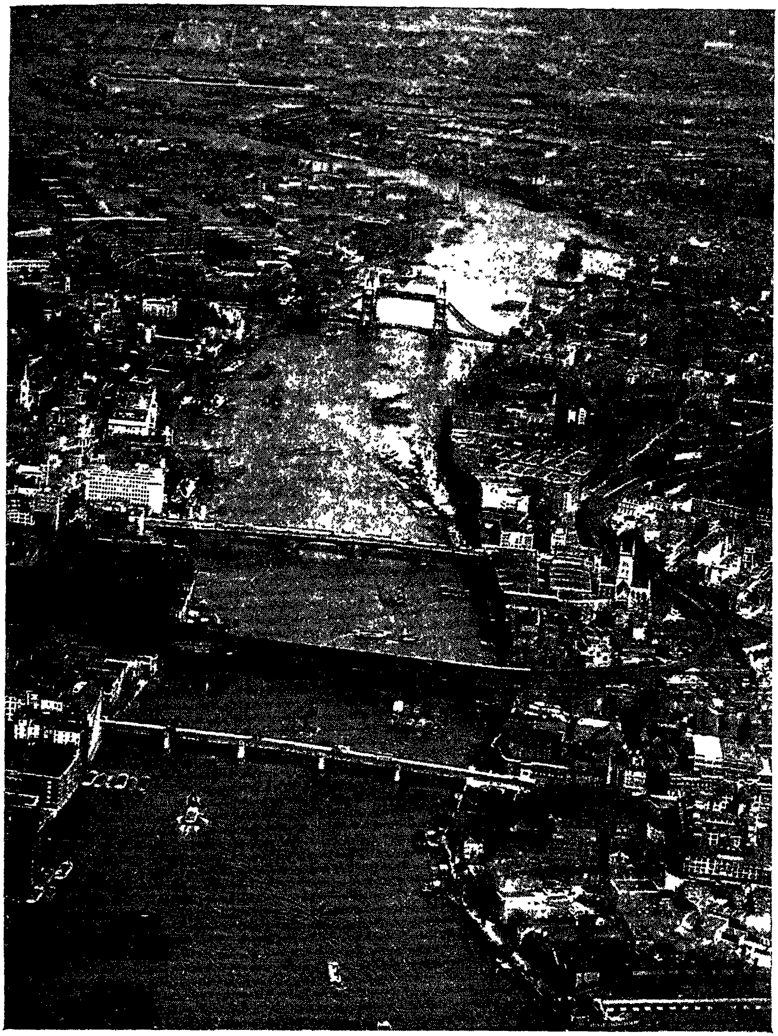
[1] This is actually the London and Home Countries traffic area set out in the London Traffic Act, 1924. It is roughly the area within a radius of 25 miles from Charing Cross, and covers 1,846 square miles.

to slightly more than the central part of the London Basin. An increasingly large number of those whose business takes them daily to London take a pride in living "outside the suburbs" and this they are enabled to do by the increased transport facilities. On the south the ever-extending electrified services of the Southern Railway run out as far as the coast at Hastings and Brighton: on the north the Metropolitan Railway runs beyond Aylesbury, whilst to the east the number of season ticket holders to Southend is very large. Most of the towns on this periphery of the London area have their local functions as market towns serving (with the help of local motor-bus services) the immediate countryside as well as their functions as dormitory towns for Londoners. High rents and rates, or the prohibitive cost of land, are driving many London firms to build their main or subsidiary factories in these peripheral towns.

The influence of the metropolis extends, of course, much farther. A very large part, if not the whole, of the five Home Counties (Middlesex, Hertfordshire, Essex, Kent, and Surrey) as well as Sussex, southern Buckinghamshire, etc., is engaged in supplying dairy produce and vegetables to the London markets. The "economic tentacles" of the metropolis thus extend out in all these directions. The motor car has brought the whole of the south-east coast from Bournemouth to Yarmouth within the normal limits of the car-owning Londoner's Saturday or Sunday trip—with a corresponding congestion on most of the direct roads.

Physical factors influencing the growth of London

The site of early London was determined in the main by the presence, near the navigable channel, of the hills, safe above flood level, now crowned by St. Paul's Cathedral and the Royal Exchange. From the early days the physical features of the whole of the London Basin have not failed to exert their influence on the growing city. Residences spread outwards along the gravel terraces and ridges where a water supply was available, but where drainage prevented a water-logging of the soil. The lower valleys of some of the streams draining to the Thames and many tracts of clay remain to us to this day as the open spaces of Hyde Park, St. James's Park, and others; the Lea Marshes still remain as marshes. For long the flood plain of the Thames itself must have presented a picture of a waste of marshland, flooded at high tide, but gradually embankment along the southern shore (opposite the City) permitted the formation of "polders" occupied by cattle pastures. Below London, the great areas of marshland, such as the Isle of Dogs, remained until the great dock building companies commenced to utilise them in the nineteenth century. With the embanking of the river on both sides the water channel was restricted within



[*Photo: Aerofilms, Ltd.*

FIG. 259.—"London River."

This view is taken looking eastwards. In the foreground are Southwark Bridge, Cannon Street Station and Railway Bridge, and London Bridge The Pool of London is between London Bridge and Tower Bridge, and the steamers of considerable size being offloaded (as at Hay's Wharf on the right) *below* London Bridge but not above show that this is the real head of ocean navigation. Beyond Tower Bridge on the left are St. Katharine Docks (surrounded by storage warehouses) and London Docks. On the right are the Surrey Commercial Docks with numerous storage sheds for timber. In the far distance is the Isle of Dogs with the West India Docks.

Notice in the bottom right-hand corner a riverside power station (cf. Fig. 262). This view shows also the Tower and Southwark Cathedral.

narrow limits and little now remains to remind us of the extent of the old flood plain. But as London grew the better residences sought the well-drained heights capped by gravel and the low-lying London Clay tracts remained undeveloped—occupied by pasture-land. The gravel terraces west of London furnished arable land, and Middlesex still sends much market-garden produce to London. The roads out of London of necessity made for the gaps through the chalk ring; settlement followed along these roads and give an early example of what has been called recently "ribbon development." At a much later stage the railways had to seek the chalk gaps and triangular tracts of untouched pasture were left between them. Some still remain: others are at present in course of development, and it is found that most which remain are low-lying London Clay tracts. Modern drainage, water supply and improved foundations have played their part, but it is still the smaller poorer residences which are springing up on these areas: the better residences seek the chalk slopes or the gravel-capped heights of the Surrey Hills or the Northern Heights. If the London Clay has forbidden a London of skyscrapers and led to a spider's web development, it has recently assisted in another way the growth of London. Holes can be bored through it with relative ease: hence the network of "tube" railways under London itself, and stretching out northwards and westwards. Where they come upon the harder chalk the "tube railways" emerge at the surface. (For details, see Figs. 42 and 43 in Chapter III.)

The Population of London

The following table serves to illustrate the changing nature of population distribution in London:

	City	Remainder of county	Outer ring	Total Greater London
1801 . . .	128,129	831,181	155,334	1,114,644
1841 . . .	123,563	1,825,714	286,067	2,235,344
1881 . . .	50,569	3,779,728	936,364	4,766,661
1921 . . .	13,709	4,484,523	2,995,678	7,480,201
1931 . . .	10,996	4,385,825	3,805,997	8,202,818

Note.—All figures before 1931 are adjusted to the modern administrative areas.

These figures are sufficient to indicate the general trend: the decreasing population of the City and adjoining "business" divisions of London. Indeed, the county as a whole has shown a declining population since 1901. The enormous increase is in the outer ring, whilst if one takes the area *outside* the "Greater London" of official reports (*i.e.* the Metropolitan Police area) the percentage

increase in the new outermost ring is even greater. These facts are shown even more clearly in the diagrams where the County, Greater London, and London Traffic area[1] are distinguished (Fig. 256).

There is thus an ever increasing outward movement of the population, but it must not be forgotten that this is accompanied by an ever increasing *daily* movement of the people from their homes in the suburbs to their offices, shops, and factories in central

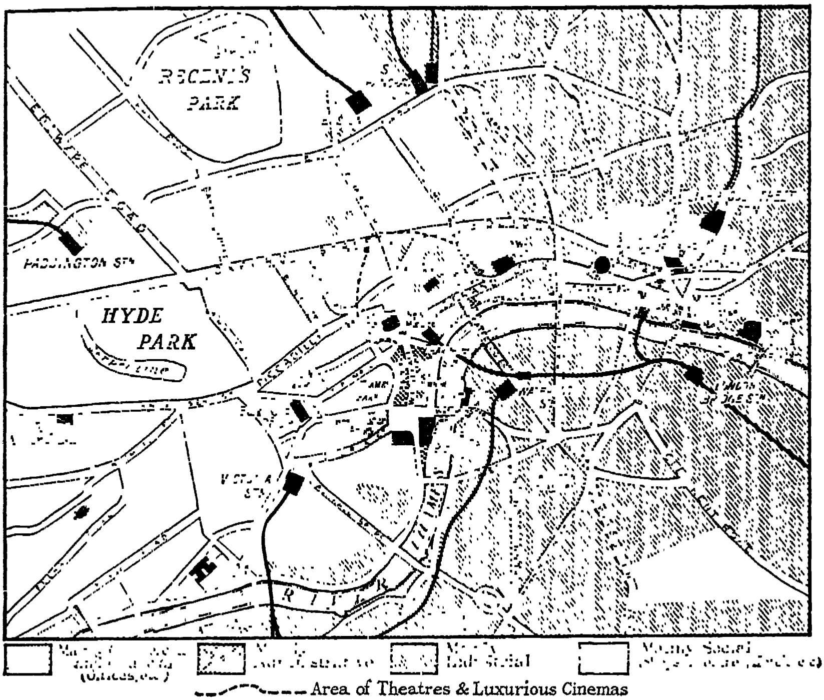


FIG. 260.—The " Functions " of London.

London is an excellent example of a large city in which definite areas are devoted to the main functions of the city. (*Map prepared by M. I. Michaels, Asst. Secretary of the New Survey of London Life and Labour.*) The blank areas are mainly residential.

London. Thus the resident population of the City of London was, according to the Census of 1921, 13,709, whilst the day population was 416,150—a net influx of 402,441 per day. In most London boroughs there is a daily movement outwards of workers going to their occupations elsewhere, and also a daily movement inwards of workers resident elsewhere. For the County of London alone the number of persons so moving daily was over 2,500,000,[2]

[1] Within which the London Passenger Transport Board operates the buses, trams, trolley buses, and underground railways.

[2] This stupendous figure represents 11 per cent. of the total occupied population of the whole of England and Wales and emphasises the remarkable mobility of London's workers.

according to the Census of 1921. The following boroughs all have a working population greater than the resident population:—

	1921 resident population	Persons moving in and out 1921	*Net* inward movement 1921
City	13,709	406,167	402,441
Westminster	141,578	270,356	232,524
Finsbury	75,995	101,008	63,482
Holborn	43,192	82,667	55,415
Marylebone	104,173	87,961	48,457
Bermondsey	119,452	56,565	17,769
Stepney	249,657	87,753	13,969
Shoreditch	104,248	63,220	9,986
Kensington	175,859	74,125	6,929
Woolwich	140,389	39,479	6,685
Poplar	162,578	56,729	5,801
St. Pancras	211,366	107,936	5,500

The other London boroughs show a net *outward* movement daily. This vast movement of people, of course, takes no account of those visiting London for shopping, etc. Broadly speaking, it is the shop and office workers who come in from the suburbs to the City: the industrial workers live near, or at least nearer their work.

The Occupations of the People of London

According to the Census returns for the County of London the principal occupations in 1921 and 1931 were as follows: (to nearest thousand over 12 years of age in 1921, over 14 years in 1931).

Occupation	Number engaged 1921			Number engaged 1931		
	Men	Women	Total	Men	Women	Total
All occupations	1,386	781	2,166	1,290	794	2,084
Agriculture (gardeners, etc.)	8	0	8	7	0	7
Makers of bricks, glass, and pottery	6	2	7	5	1	6
Chemical workers (including paints)	8	3	11	5	1	6
General metal workers	116	9	124 *	103	8	111 *
Electrical apparatus	24	5	29	26	6	32
Precious metals	5	1	6	4	0	4
Watch and clock makers	5	0	6	2	0	3
Leather workers	13	8	21	12	9	21
Textile workers	3	4	7	2	3	5
Clothing, boots and shoes	53	113	166 *	50	122	172 *
Food, drink, and tobacco workers	27	19	46	21	11	32
Workers in wood and furniture	70	7	77	63	5	68
Paper makers, printers, etc.	43	31	74	39	24	63
Building trades	46	0	46	63	0	63
Painters	37	1	37	45	3	48

* Note these *leading* occupations. Figures include those unemployed.

Occupation	Number engaged 1921			Number engaged 1931		
	Men	Women	Total	Men	Women	Total
Transport workers	253	13	266 *	252	13	266 *
Railway services	*30*	*0*	*30*	*24*	*0*	*24*
Road services	*105*	*1*	*105*	*112*	*0*	*112*
Water services and docks .	*41*	*0*	*41*	*36*	*0*	*36*
Commerce (including shop assistants)	163	62	226 *	196	73	269 *
Public administration . . .	72	18	90	331	1	34
Professional (including teachers)	46	51	97	46	52	98 *
Entertainments	14	7	21	17	7	23
Domestic	77	279	356 *	105	310	414 *
Clerical	102	98	200 *	129	124	254 *
Warehouses, packing, etc. . .	45	25	70	50	32	82
Unskilled labourers	86	3	91	120	30	150

* Note these *leading* occupations. Figures include those unemployed.

If we glance over this list we notice that the transport services—the railways, road, and water services—occupy more than a quarter of a million of London's workers, and the number so employed is only exceeded by those in domestic service. Commerce and the shops and the clerical staffs of offices each account for more than 200,000 persons.

But looking upon London as an *industrial* or *manufacturing* centre, the table shows the outstanding importance of the clothing, boot and shoe, metal, furniture, and paper trades, each employing more than 70,000 hands. The above table and figures are for the County of London. But in 1930 the population of Greater London was rather over 8 millions, of whom $3\frac{3}{4}$ millions were "occupied" ($3\frac{1}{2}$ millions of them between 16 and 65). About two-thirds of the occupied persons are employees earning less than £250 a year, and so insured under the Unemployment Insurance Acts. Thus the insurance cards cover about $2\frac{1}{4}$ millions of London's workers, and this forms the best basis for the study of London's industries.

One of the striking things about industrial London is the immense number of small undertakings. Nine-tenths of the employers in London (not counting employers of less than 10 hands) employ less than 100 hands. In 1930, there were only 34 undertakings in the whole of Greater London employing more than 2,000 men. However, even so, nearly half the workers are employed by one-twentieth of the firms.[1]

The mechanisation of London's industries has been proceeding rapidly, especially in the outer ring, where new and up-to-date factories are being established. The change is marked even since 1921. There were then 57,000 factories and workshops in the whole

[1] Details from *The New Survey of London Life and Labour*, II. "London Industries." London. P. S. King & Sons, Ltd., 1931.

London area (*i.e.* rather beyond Greater London) of which 42 per cent. were factories, that is establishments using power-driven machinery. By 1929 the total had fallen to 55,500, but factories number 54 per cent. of the whole. See also below, p. 617.

Decentralisation in London.[1]—The outstanding fact of post-war industrial development in England has been the move southwards, especially or mainly to London, of numerous workers from the north and midlands. It is definitely wrong to state that the *industries* have moved southwards: those of London are for the most part of a different type, and among them are especially *new* industries (*e.g.* connected with electricity, wireless, etc.). The outstanding feature in London itself has been the general movement towards decentralisation. It must be admitted that the development of new factory areas in and near London has been, in the main, haphazard. It is obvious that (*a*) labour supply; (*b*) space for expansion; (*c*) transport facilities; (*d*) relation to markets, and (*e*) water, gas, and electricity supplies and costs, and rates are leading factors.

The small factory must needs be erected near an existing labour supply. But labour is mobile and a large unit, complete with housing scheme, can attract labour to itself. So there has been the rise of new industrial centres, notably at Letchworth (no less than 35 miles from London) and Welwyn (21 miles). There is a difference of opinion amongst manufacturers as to whether the factory to be erected near an existing residential tract should be on the outskirts so that the workers go *outwards* to their work, but have the amenities of town life at their doors, or whether the factory should be as central as possible and the workers come *inwards* to their work from homes where circumstances permit of small gardens for each. There is no doubt that want of space for expansion is by far the most important reason for moving an established industry.[2] In choosing the new site, transport facilities play a large part. For heavy and exporting industries (and for industries dependent upon bulky imported raw material) the importance of the nearness to the river or docks is paramount. This is very clear in the case of such industries as :—

(*a*) Electric power works and gas works—all using water-borne coal and practically all situated near the river or waterways, such as the Regents Canal.

(*b*) Cement works, an example of a heavy and exporting industry, using chalk, mud or clay and water-borne coal, all along the Thames below Dartford, and the Medway.

(*c*) Paper works, petroleum refineries, grain mills, and sugar factories using bulky imported raw materials.

[1] R. Unwin: *Interim Report on Decentralisation, January* 1931. Greater London Regional Planning Committee.

[2] The modern mechanised factory requires a horizontal lay-out rather than a vertical one, hence the great demand for space.

On the other hand, for lighter industries and those supplying primarily or largely the home market, nearness to the main railway lines or arterial roads is more essential. This is clearly exemplified by the almost continuous succession of post-war factories along the

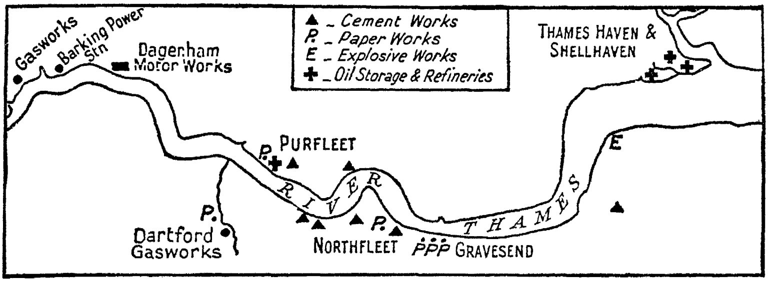


FIG. 261.—Riverside industries of the Thames below London.

In particular "heavy" industries and those carried out away from main centres of settlement. (Compare oil refining and manufacture of explosives.) (*After Ll. Rodwell Jones.*)

Great Western main line from Ealing through Slough, with such examples as the gramophone works (H.M.V.) at Hayes, Middlesex, and the gigantic bakeries of J. Lyons & Co., Ltd. In the case of modern arterial roads, the Great West Road and the Kingston By-Pass afford outstanding examples.

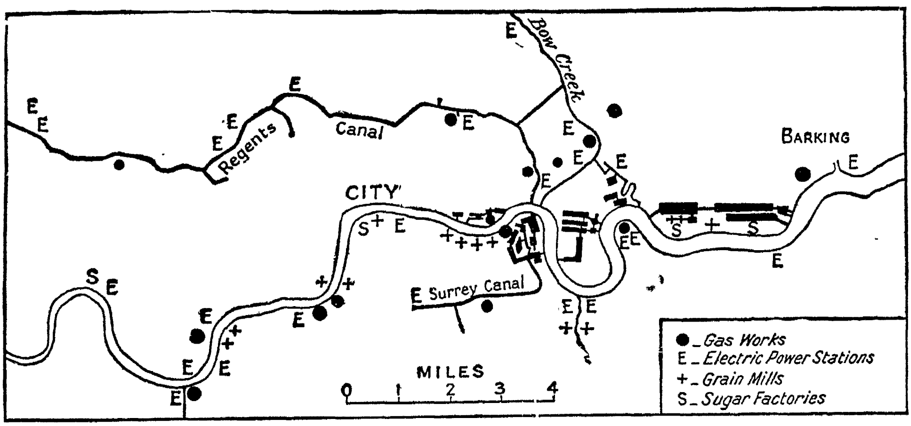


FIG. 262.—Riverside industries of the Thames at London.

This map shows that all the major power stations and gas works have water connections (major stations only included). (*After Ll. Rodwell Jones.*)

This separation of heavy and light industries fortunately operates to a considerable extent in another way. It coincides to some extent with a separation between "dirty" and "clean" industries—to the advantage of residential areas.

There is, of course, another great factor at work where essentially

skilled labour is required—the factor which may be called inertia. It operates in the clothing industry which has expanded in the east and north-east of London rather than changed its location.

Mention was made above of the relation to markets. There are several points of view here. Those manufacturers who depend on the London area as their chief market must be near at hand for delivery; those who rely on London as an international mart and are manufacturing for export must be near both for shipment of goods and to permit foreign buyers to inspect their goods. A foreign buyer might well cut off from his list a factory whose warehouse was inconveniently far away for him to visit. The makers of bulky or standardised articles, of course, get over this by a showroom in London, but even then comes the difficulty that the buyer cannot talk personally with the principals of the business.

The facilities for the supply of gas and electric power, especially in the case of the latter, are undergoing a change, and the amazing differences in cost of electricity from one area to another are disappearing as the grid for the country becomes complete.

We are now in a position to see how these factors have operated in the post-war expansion of industrial London [1] (up to 1930).

	Number of new factories	Number of new factory employees
London County	752	76,416
Outer ring (of Greater London) .	322	46,461
Outermost ring	71	8,692
	1,145	131,569

It is interesting to note that while the population of the County of London has, as a whole, decreased, the factory employees have increased by over 76,000. Probably many of these come in to their work from the outer ring.

This table shows the direction of the expansion by number of new employees :—

	London County area	Greater London		Outer London	Total
		Inner	Outer		
N.E. & E. (Essex) (L.N.E.R. and riverside)	32,180	8,844	585	2,548	44,157
S.E. (Kent) (S.R. and riverside) .	14,458	390	197	601	15,646
S. & S. W. (Surrey) (S.R.) . .	8,343	7,811	290	2,173	18,617
W. (S.W. Middlesex and Bucks) (G.W.R.)	10,649	11,939	1,979	2,810	27,377
N. (N.E. Middlesex and Herts) (L.M.S.)	10,786	13,837	589	590	25,772
	76,416	42,821	3,640	8,722	131,569

[1] Quoted from R. Unwin, *op. cit.*, *sup.*

The East End in 1930.[1]—There have been great changes in the East End in the last fifty years. Then shipbuilding was important and transport was entirely drawn by horse-drawn vehicles and the sulphur-laden Metropolitan Railway. The population is decreasing —797,000 in 1921, 749,000 in 1931.[2] Two out of every five of the population are engaged in industry, say 311,000.

JULY AND AUGUST, 1930 (BY INSURANCE BOOKS EXCHANGED)
(In Thousands Employed, ignoring less than 500)

	Poplar	Shoreditch and Bethnal Green	Stepney	Canning Town	Total
Building	2·2	2·5	2·9	1·6	9·1
Constructional work	1·1	0·6	—	0·8	2·4
Shipbuilding	1·7	—	—	5·6	7·3
Engineering, including motors	2·0	2·1	1·3	0·7	6·8
Saw mills and wood working, including Furniture	1·2	15·8	1·4	—	19·4
Chemicals, oils, greases and paints	1·6	0·7	0·9	3·6	6·9
Brass, copper, zinc	0·9	—	—	—	0·9
Electrical apparatus	0·7	—	—	—	0·7
Cutlery	—	0·6	—	—	0·6
Other metals	—	2·1	0·6	0·6	3·3
Rubber	—	1·7	—	2·5	4·2
Leather tanning (including furs)	—	1·1	1·8	—	2·9
Leather goods	—	2·5	—	—	2·5
Glass	—	0·7	—	0·9	1·6
Hotels, restaurants	0·8	3·0	3·6	1·1	8·5
Commerce	—	0·9	1·6	—	2·4
Railways	0·6	3·6	—	—	4·3
Road transport	1·7	4·8	3·3	0·5	10·4
Shipping	2·1	—	3·7	6·2	12·1
Docks	6·3	—	13·1	6·7	26·1
Cardboard boxes	—	4·6	0·6	—	5·1
Printing	—	9·4	2·1	1·2	12·8
Textiles, tailoring, dress-making, hats, blouses, shirts, and other dress	2·5	14·5	24·0	0·6	41·6
Boots and shoes	—	1·6	1·1	—	2·7
Bread, biscuits	1·9	—	3·0	1·2	6·1
Tobacco	—	5·7	3·4	—	9·1
Other goods	2·0	0·7	—	6·8	9·5
Drinks	0·7	1·0	3·5	—	5·3
Gas, water, etc.	—	1·3	1·0	1·6	3·9
Distributive	3·9	14·0	24·5	4·7	47·0
National Government	—	—	0·5	—	0·5
Local Government	—	—	1·9	—	1·9
Professional	—	1·3	1·0	—	2·3
Other industries	0·7	2·0	1·3	0·6	4·6

[1] From T. Park (*Ministry of Labour London Divisional Office*) unpublished paper read at Toynbee Hall, December 10th, 1930. Includes Shoreditch, Bethnal Green, Stepney and Poplar with that part of the borough of West Ham which falls to Canning Town and Silvertown. (*By kind permission.*)

[2] The decrease has been confined to that portion of the East End falling within the County of London.

In the five boroughs there is much daily movement of workers. According to the Census of 1921, 172,000 move out (to the City, etc.), 167,000 move in (to factories), whilst 52,000 move from one borough to another within the limits of the East End itself. Shoreditch and Bethnal Green thus form the " city of the smaller trades and the lesser ingenuities "—the metropolis of the furniture trade. Stepney, on the other hand, takes precedence in the clothing trades. Tobacco is important in both. Naturally the dockers are in the riverside boroughs, and so are the ship repairers.

Apart from the workers engaged in the distribution of goods the clothing trades take precedence from the point of view of numbers employed. Several points call for comment. London does not to any appreciable extent manufacture textiles. The textiles required for the clothing trades are imported. In the second place a distinction must be drawn between factories where power-driven machinery is employed and workrooms where the work is done by hand or hand-operated machines. Of recent years there has been a marked increase in the number of factories and the numbers employed, but there are still hundreds of small employers with from one to five or more " hands " carrying on their businesses in small workrooms or in a house which is used in part as a residence, in part as a workshop. Homework, or work taken home by these employees, is much less important than formerly.

Similarly with the furniture trades. More than half the output is still from small workshops, but the small man usually specialises, often in one process. The chair-frame maker may do nothing else ; a man may do nothing else but turn legs for tables. One of the commonest sights in Shoreditch is the man with his barrow-load of partly made furniture en route for the next stage in its manufacture.

Printing and cardboard-box making occupy an important position, and so does the preparation of foodstuffs and tobacco.

Shipbuilding and ship repairing were once among the most important industries. Now shipbuilding is a thing of the past, and but a handful of men are left to carry on the work of repairing. The work, too, is spasmodic, a " rush job " is succeeded by a period of enforced idleness. To some extent the modern engineering industry has grown out of the old shipbuilding.

Whilst the home of leather tanning and the leather industry is in Bermondsey across the river, the manufacture of leather goods is by no means unimportant in the East End where, however, fur-dressing and furriery is particularly important. But what must again be stressed is the immense variety of miscellaneous industries—old crafts such as that of the bell-founders of Stepney or the silk workers of Spitalfields, still using hand looms as old as the industry itself, being found side by side with the manu-

facturers of wireless parts and the latest requirements of modern life.

London's Wholesale Markets.—The covered retail markets of London, small and few, are insignificant when compared with the great covered markets of such towns as Liverpool and Birmingham. London's street markets are more comparable with the covered retail markets of the provinces, and play an important part in London life.[1] But London's wholesale markets occupy a unique position in that to a large extent they determine or influence prices throughout the country, and are an outward and visible sign of

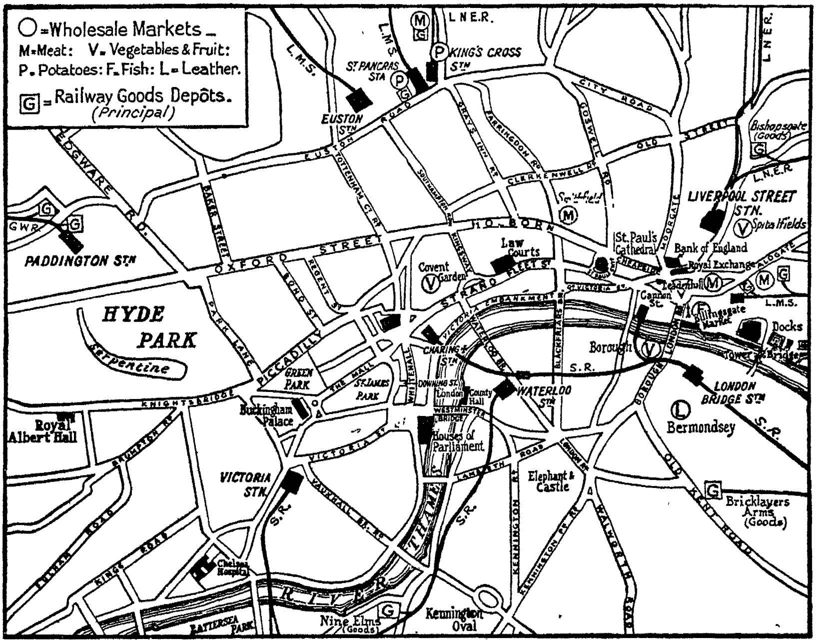


FIG. 263.—London's wholesale markets.

Shown in relation to the main railway termini and the docks.

London's pre-eminence as a commercial centre. In a very large number of commodities transactions are carried out by sample so that the " markets " are merely certain streets in the City where firms specialising in certain commodities have their offices located. The tea " market " is in Mincing Lane, the jute " market," sugar " market," etc., near at hand. But in the case of foodstuffs where freshness is essential (meat, fish, and vegetables) the commodities are actually brought to the markets of the metropolis for sale.

The City Corporation of London owns five markets, viz. the

[1] See *New Survey of London Life and Labour*, III, Chapter XIII, p. 290.

London Central Meat Market at Smithfield, the Metropolitan Cattle Market and Abattoir at Islington, and the markets at Spitalfields, Billingsgate, and Leadenhall. Covent Garden is owned by a public company, two railhead markets by the railway companies concerned. It is interesting that no markets are controlled by the London County Council which came really too late on the scene. Some of the markets, such as the L.C. Meat Market, serve mainly the London area; others, such as Covent Garden, serve practically the whole country, and there has been much discussion as to devising some means to obviate the delay and expense of repeated handlings necessary to bring such commodities as imported fruit to Covent Garden before re-consigning it to distant parts of the country.[1]

Covent Garden.—Covent Garden is still the principal centre of Great Britain dealing in imported fruit and vegetables, though it has an important rival in the London Fruit Exchange at Spitalfields. Covent Garden also handles a seasonal surplus of fruit from south-eastern England. The market was founded in 1670 in the reign of Charles II, and from that date to 1918 was the property of, and managed by, the agents of the Earls of Bedford. It was then sold and has now passed into the hands of the Covent Garden Properties Co., Ltd. The market itself covers $5\frac{3}{4}$ acres including open squares, covered market buildings and a Floral Hall where auctions take place. Most of the premises in the neighbouring streets are occupied by firms in the fruit and vegetable trade. The 1,200 stalls of the market are occupied by 550 regular tenants and a number of English growers at certain seasons. The market is chiefly active between 3 a.m. and 6 a.m., when the home-grown supplies reach the market, and a census taken in 1926 showed that over 5,000 vehicles went into the market and over 5,000 left it in one day—20 per cent. to or from railway termini. The market handled 360,000 tons of produce in 1910, but in 1929 this had swollen to a million tons (750,000 in the market itself, 250,000 by firms at their private premises). It cannot be claimed that the market premises are up to date, and the congestion is notorious.

Spitalfields.—The market founded originally in 1682 was long associated with the old fine silk industry of the area. It finally passed into the hands of the City Corporation in 1920 and by 1928 had been enlarged from two to five acres, and is now the market for fruit and vegetables, drawing its produce mainly from Essex and the eastern Home counties, and supplying the populous east and north-east of London. Of the 600,000 tons of produce handled (1929) about half are potatoes, but the provision of a fine building in 1929 (the Fruit Exchange) of about an acre, as well as the proximity of the docks and the fact that a van or lorry can draw right up to the stands has encouraged dealing in imported fruit and vegetables.

Stratford.—This is a fruit and vegetable market adjoining, and constructed in 1878 by, the old Great Eastern Railway (now part of the L.N.E.R.). It derives its supplies from the counties on that line and supplies the eastern end of the metropolis—handling over 100,000 tons per annum. The railhead depots at King's Cross and Somer's Town have a similar function—handling the potatoes and vegetables of the Fenlands in particular; while the Borough Market (owned by the churchwardens of Southwark Cathedral) serves the south of London. Greenwich has also a small wholesale fruit market.

[1] A South African farmer once told the writer that a case of oranges was handled fifteen times before it was opened in a retailer's shop in England. Five of these were necessitated by the existence of the Covent Garden system.

The London Provision Exchange.—Established in 1887, this market handles the whole of the bacon and ham imported into London—about half of the total imports of the country (total 9,300,000 cwt., valued at £49,000,000 in 1929). It is concerned also with butter, cheese, lard, and canned goods.

Smithfield.—The London Central Market, owned and operated by the Corporation of the City of London under a charter of Edward III, covers now an area of 10 acres and is the principal meat market, dealing also in eggs, poultry, game, butter, and cheese. From the point of view of ease of approach and facilities for handling the meat, Smithfield is the best of London's markets. 60,000 sides of beef (about 9,000 tons) can be displayed at once: there are external loading points for 350 three-ton lorries at one time and 31 ample gates to the market itself. A great change has taken place in the last 30 or 40 years by the development of refrigeration. There are numerous cold stores adjacent to the market, and there is no longer the old Saturday morning rush to clear off stocks before the week-end. The incoming lorries deliver their loads and are away between 4 a.m. and 6 a.m. The retail butchers do most of their purchasing between 6 a.m. and 8 a.m.

Islington.—Islington Market has an area of 15 acres and has a live cattle sale twice a week. But it is especially important as including London's chief slaughter houses. There is a total hanging capacity for 750 cattle, 1,900 sheep, 500 calves, and 1,800 pigs. Most of the meat goes to Smithfield.

Leadenhall Market.—Handles mainly poultry and, not being far from Billingsgate, is convenient for retailers who sell both fish and poultry; though more poultry is being handled at Smithfield. There is also an important retail market. London meat markets handle 470,000 tons a year (1931–35).

Billingsgate.—Billingsgate fish market more than rivals Covent Garden in historic interest. It is the oldest of the markets controlled by the City Corporation, and its site—by the river-side around a small haven just below London Bridge—was inevitable when most of the supplies were water borne. Actually the proportion of water-borne deliveries has now dropped to about one-eighth or 12 per cent. of the total (30 or 40 per cent. pre-war) and the bulk has therefore to be brought from the great railway termini. In 1920 more than half the fish handled came from stations more than 2½ miles away. Although the market serves primarily London and the south-eastern counties, not a small proportion is conveyed to distant points in the south—possibly not far from where the fish was originally landed. The market itself, with an area of about an acre, is incapable of accommodating the quantity of fish to be sold, which is about 650–750 tons per day. Thus much of the selling is by samples, and delivery can be made from the railway companies' vans which line the "Inner Circle" of streets surrounding the market direct to the waiting buyers' vans which line the "Outer Circle" of side streets. The market opens at 5 a.m. when deliveries arrive from the special night fish trains. Retailers arrive at 6 o'clock and most of the business is over by 8 a.m. and the streets clear before the great throng of city workers pours through the neighbouring thoroughfares at 9.0 or 9.30.

The other markets are indicated on Fig. 263, and in particular the Hop Exchange should be noted.

The Future Development of London

Modern London illustrates in a remarkable way the separation, which is characteristic of most of the very large modern centres, of areas serving each of the five great functions of a city: the commercial, the administrative, the industrial, the social, and the

residential. The heart of commercial London is the City with its banks, its insurance houses, its business premises, its warehouses, and its markets. On the one side to the east it is very closely linked with the Port of London. Much of the buying and selling is actually done by samples in the City whilst the goods themselves remain in the Port. The growth of commercial London continues. It has been shown that it has driven out a resident population. It is spreading westwards. Bush House is outside the city limits. More recently the replacement of the old Cecil Hotel by the giant Shell Mex building is an indication of the spread of commercial London, and it has invaded Westminster with Thames House and Imperial Chemical Building. Industrial London is quite distinct. Social London is the West End. Here in juxta-position are the theatres, the picture houses, the large stores, and attractive shops, the clubs, restaurants, and hotels within reasonable access to the principal railway termini.

The important point for the future planning of London is to realise the inseparability of these different entities which comprise social London. But the social amenities demand a resident population, whether it is for running the hotels and the clubs or whether it is for the residences of those whose close contact with social life practically involves a residence within easy reach. Pressure of space has driven the exclusive residential clientele out of Mayfair or from Mayfair houses into the gigantic blocks of luxury flats which have become a feature of post-1918 London. The fourth function is that of residential London—the dormitory, suburbs, and ring of outer towns. And here there are three requirements. One is accessibility from commercial London where so many of the residents work during the day, the other is accessibility from social London for recreation or amusement or failing that the development of comparable amenities within the residential area itself. Thus a large residential centre without the social amenities of theatres and shops cannot be regarded as successful. The planning of future London, then, cannot be carried out by segregating factories or industries in one place, purely residential areas in another, shopping centres in a third, and so on. Two things must be gauged and gauged accurately: (1) The trend of future public taste. Just at the moment the Englishman of all classes is divided between his former allegiance to house and garden, be it large or small, and the new found advantages of life in a flat—whether it be the modest flat with labour-saving devices which obviate the necessity of domestic help—or the luxury service flat. It seems impossible to judge how the future trend will develop between these two. (2) The second great factor is the adequate arrangement for the placing in sufficiently close proximity, but to the mutual advantage of all concerned, of those buildings which represent in turn the different

functions of a major settlement, and of providing in all cases for adequate facilities for open spaces.

The growth of London has led to the urgent consideration of those matters already mentioned in the footnote on p. 573. The incredible spread of the metropolis and its effect on the rural surroundings has been studied in detail by Dr. E. C. Willatts in his Report on Middlesex and the London Region (*The Land of Britain*, the Final Report of the Land Utilisation Survey of Britain) and it is clear that the great scheme for a "Green Belt"—a ring of land for recreational purposes—round Greater London came not a moment too soon. The enormous post-1918 spread of housing estates is clearly shown on the Land Utilisation Survey's one-inch maps (sheets 106, 107, 114, and 115) and calls for special study.

A question brought very much to the fore is the question, Should London be *allowed* to grow? Up to 1936 there had been 9,000 new factories built since 1924. The transport of London's workers from their homes to their work threatens to become an insoluble problem despite the coordination of the transport services under the L.P.T.B. and new schemes for railway electrification in north and north-east and the south.

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CHAPTER XXIX

THE INDUSTRIAL REGIONS OF IRELAND

On the whole Ireland is still essentially agricultural, and the separation of Northern Ireland from Eire resulted in divorcing the regions which are devoted to manufacture, and which are mainly situated in Northern Ireland, from the almost purely rural or agricultural counties which comprise Eire. Since the separation, however, and especially since the development of the Shannon hydro-electric power, much progress has been made in industry in Eire.

NORTHERN IRELAND

In the $3\frac{1}{2}$ million acres which comprise Northern Ireland there is a population of approximately $1\frac{1}{4}$ million. Of these no less than 415,000 live in the industrial centre of Belfast, the capital city. Londonderry has a population of 45,000, whilst Ballymena, Lurgan, Portadown, Newry, Lisburn, Bangor, and Newtownards are all towns with more than 10,000 inhabitants. In all rather more than half the population live in settlements of more than a thousand people and which are shown on Figs. 264 and 235. Northern Ireland has four principal industrial areas, of which the first is by far the most important :—

(1) *Belfast and District.*—Here the main industries are the manufacture of linen, shipbuilding, engineering, rope making, distilling, soap making, the preparation of tobacco and aerated waters. The port of Belfast, which forms the main channel for the import and export trade of the country, is described elsewhere (Chapter XXXI).

(2) *The Lagan Valley.*—The country south of Lough Neagh has several centres in which linen is manufactured. Linen manufacture is the principal industry in Northern Ireland and it employs directly or through subsidiary trades over 100,000 workers. There are 35,000 looms and 900,000 spindles. During the year 1930[1] the value of linen exported from the United Kingdom was £$7\frac{1}{2}$ million sterling, practically the whole of which came from Northern Ireland. The Belfast shipyards employ roughly 11,000 persons and possess an output capacity exceeding 250,000 tons a year. The engineering industry of Belfast and district is closely allied to the linen and

[1] 1935 £6,500,000.

shipbuilding trades in which machinery of all kinds plays a leading part.

(3) *The City of Londonderry and District.*—The chief industries are the manufacture of such made-up goods as shirts and collars. Londonderry itself is the second port of Northern Ireland.

(4) *The Hinterland of the Port of Newry.*—Again, linen manufacture is carried on and also the manufacture of a limited amount of woollen goods.

The two chief industries of Northern Ireland have thus been dealt with above: shipbuilding (p. 387), linen (p. 511), and the ports

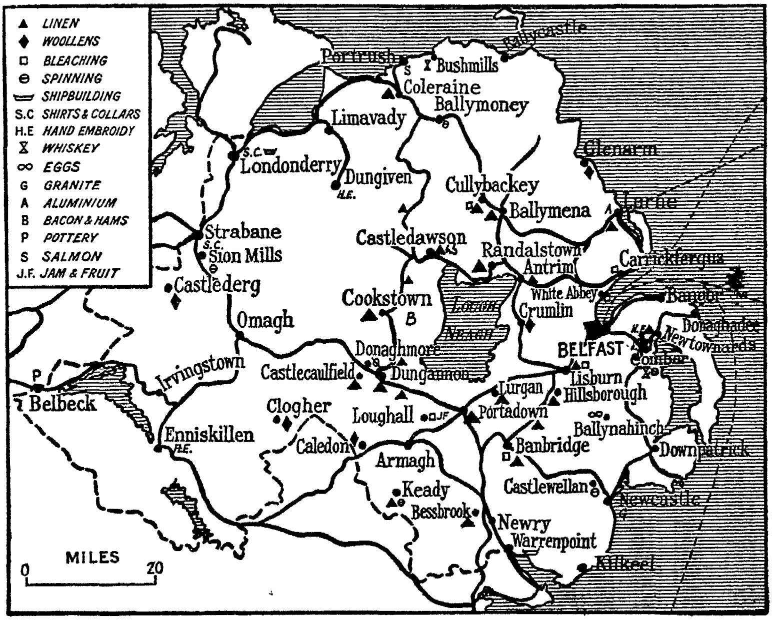

FIG. 264.—The town and industries of Northern Ireland.

are considered in Chapter XXXI. For its development as a manufacturing region, of course, Northern Ireland suffers from the initial disadvantage of the absence of fuel. Mention may here be made of the proposals which have been put forward for utilising the fall of the river Bann from Lough Neagh to the sea for the generation of electric power. The scheme for the improvement of the drainage of the valley which will prevent the flooding of the lowlands goes hand in hand with the electrification scheme; but the work at present in hand is essentially the drainage. It is possible that Northern Ireland may instead buy electric power from the Free State to the mutual advantage of both.

EIRE

The pre-eminence of agriculture in Eire may be gauged from a consideration of the following table showing the value of output of the different industries :—

Agricultural produce (1926–27)	£164,750,000
Fisheries (1927) approx.	£1,100,000
All manufactures (1926)	£24,190,000

In this table the value of all manufactures is *net* output value, that is the value added during the process of manufacture to the cost of the original raw material. Many manufactures in Eire are concerned primarily with the utilisation of the agricultural produce of the country. Thus from the point of view of the value of the products the two leading industries are brewing and the preparation of butter, cheese, and margarine. Nearly all Ireland's home-grown barley goes to supply the brewing industry, and there is a considerable import of barley in addition.

Dublin.—Dublin is easily the most important manufacturing centre in Ireland. Brewing is the leading industry. The famous St. James's Gate Brewery where Guiness's stout is made is the largest brewery in the world. It employs no less than 3,000 people, and with the wives and families it may, therefore, be said to support no less than 12,000 people out of a total population for the city of 405,000. Dublin shows the characteristic feature of so many ports of Britain in the centring there of the flour-milling industry. If one takes flour milling and biscuit making together, that forms the second great industry of Dublin. Dublin biscuits, particularly Jacobs', have become so well known that there is a considerable export. There are also small industries such as the manufacture of woollens, clothing, boots, and shoes, furniture, etc., but they are mainly of local importance.

Other Manufacturing Centres.—The most important centres are Cork, Limerick, Waterford, and Wexford. All these are famed for their bacon-curing establishments. Cork deserves a special mention because of the centre there for the assembly of motor cars ; there are the large Ford works capable of supplying the greater part of the requirements of Ireland. Only the future can tell how far the large amount of power available from the Shannon Power Works (see p. 93) will induce the further development of manufactures in Eire.

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CHAPTER XXX

THE SEAPORTS OF GREAT BRITAIN [1]

THE first table given below illustrates two facts of outstanding importance. The first is the concentration of the huge trade of the United Kingdom in a few major ports. Thus the first six on the list handle three-quarters of the total traffic, or the first eight on the list more than four-fifths. Even more remarkable are the figures for the first two—London and Liverpool between them handling between 55 and 60 per cent. of the total foreign trade of the United Kingdom. The second point of importance is that this concentration of trade in the major ports has been a feature of the growth of British trade for a long time and, what is perhaps still more significant, it is still going on. The study of the development of British ports affords many interesting examples of the

I. TRADE OF THE LEADING PORTS EXPRESSED AS A PERCENTAGE OF VALUE OF THE TOTAL TRADE.

	1913	1926–30	1931	1935
London	29·3	34·5	39·3	37·7
Liverpool	26·4	23·3	19·5	22·0
Hull	6·3	5·3	5·7	6·0
Manchester	4·0	4·7	4·4	4·3
Southampton	3·8	4·5	4·7	4·4
Glasgow	3·9	4·0	3·8	3·8
Harwich	2·4	2·5	3·6	2·0
Tyne Ports	1·7	1·9	2·2	1·9
Dover and Folkestone	2·5	1·8	1·9	1·2
Bristol	1·5	1·8	2·0	2·0
Grimsby	2·7	1·7	2·0	1·4
Goole	1·3	1·3	1·4	1·1
Leith	1·6	1·3	1·4	1·1
Cardiff	1·7	1·1	1·4	1·1
Newhaven	1·5	0·7	0·9	0·6
Other ports, Gt. Britain	8·0	8·3	5·7	8·3
Ireland	1·4	1·3		1·3

The first six (London, Liverpool, Hull, Manchester, Southampton, and Glasgow) 73·7 per cent. of the total in 1913; 76·3 per cent. in 1926–30; in 1931 77·4 per cent.; in 1935 80·2 per cent.

[1] The authors are greatly indebted to Professor Ll. Rodwell Jones for valued criticism on this chapter, and also to Mr. W. G. East.

II. THE LEADING BRITISH PORTS ARRANGED ACCORDING TO THE VALUE OF THEIR TRADE (IN £ MILLION STERLING)

Port	1913	1921–25 average	1926–30 average	1931	1935
London. Total	411·8	634·6	681·9	492·4	466·7
Imports	*253·9*	*423·3*	*470·4*	*366·4*	*321·4*
Exports	*99·1*	*139·1*	*148·1*	*89·2*	*112·2*
Re-exports	*58·8*	*72·2*	*67·5*	*36·8*	*33·1*
Liverpool. Total	370·8	541·5	460·6	244·0	271·8
Imports	*175·5*	*255·0*	*220·4*	*131·7*	*139·8*
Exports	*170·1*	*262·2*	*222·8*	*105·2*	*125·5*
Re-exports	*25·2*	*24·3*	*17·4*	*7·2*	*6·5*
Hull. Total	84·6	106·3	104·1	71·3	74·4
Imports	*49·8*	*69·0*	*71·4*	*50·8*	*48·5*
Exports	*29·2*	*34·3*	*31·2*	*19·6*	*24·8*
Re-exports	*5·6*	*3·0*	*1·5*	*0·8*	*1·1*
Manchester. Total	56·3	100·6	93·1	55·1	52·9
Imports	*35·3*	*60·9*	*63·0*	*40·6*	*39·8*
Exports	*20·6*	*38·5*	*29·4*	*13·9*	*12·8*
Re-exports	*0·4*	*1·2*	*0·7*	*0·5*	*0·4*
Southampton. Total	53·6	75·6	88·9	55·6	54·9
Imports	*25·5*	*35·2*	*40·6*	*28·6*	*26·1*
Exports	*20·7*	*30·7*	*37·2*	*22·6*	*23·5*
Re-exports	*7·4*	*9·7*	*11·1*	*7·4*	*5·3*
Glasgow. Total	54·8	85·8	79·5	47·3	46·7
Imports	*18·5*	*30·8*	*29·9*	*20·8*	*20·1*
Exports	*35·9*	*53·9*	*48·6*	*25·8*	*26·1*
Re-exports	*0·4*	*1·1*	*1·0*	*0·7*	*0·5*
Harwich. Total	34·3	38·4	48·4	45·3	25·0
Imports	*25·6*	*33·3*	*41·8*	*40·1*	*20·1*
Exports	*6·0*	*3·2*	*4·9*	*3·6*	*3·7*
Re-exports	*2·7*	*1·9*	*1·7*	*1·6*	*1·3*
Tyne Ports. Total	24·6	43·2	36·9	28·8	23·1
Imports	*11·4*	*19·0*	*20·9*	*16·4*	*11·6*
Exports	*13·2*	*24·0*	*15·8*	*12·3*	*11·3*
Re-exports	*0·0*	*0·2*	*0·2*	*0·1*	*0·1*
Dover and Folkestone. Total	35·2	42·1	35·3	23·6	15·6
Imports	*24·4*	*30·2*	*22·7*	*14·9*	*8·7*
Exports	*6·7*	*6·1*	*6·9*	*5·7*	*4·4*
Re-exports	*4·1*	*5·8*	*5·7*	*3·0*	*2·5*
Bristol. Total	22·1	38·8	35·0	24·6	24·6
Imports	*18·0*	*33·4*	*30·9*	*22·9*	*23·4*
Exports	*4·0*	*5·0*	*3·7*	*1·5*	*0·9*
Re-exports	*0·1*	*0·4*	*0·4*	*0·2*	*0·3*
Grimsby. Total	37·9	34·9	34·0	24·6	17·4
Imports	*15·9*	*16·5*	*21·6*	*17·7*	*12·3*
Exports	*21·9*	*18·3*	*12·0*	*6·9*	*5·1*
Re-exports	*0·1*	*0·1*	*0·4*	*0·05*	*0·05*

Port	1913	1921–25 average	1926–30 average	1931	1935
Goole. Total	18·8	28·0	25·8	17·8	13·1
Imports	*8·4*	*10·8*	*12·2*	*9·7*	*5·0*
Exports	*10·3*	*17·0*	*13·5*	*8·0*	*8·0*
Re-exports	*0·1*	*0·2*	*0·1*	*0·1*	*0·1*
Leith. Total	23·0	26·4	24·6	17·5	13·3
Imports	*15·8*	*19·1*	*19·0*	*13·4*	*10·1*
Exports	*6·9*	*6·9*	*5·4*	*3·9*	*3·1*
Re-exports	*0·3*	*0·4*	*0·2*	*0·1*	*0·1*
Cardiff. Total	23·9	31·6	22·5	16·9	13·1
Imports	*6·7*	*10·2*	*9·6*	*6·5*	*4·8*
Exports	*17·2*	*21·4*	*12·9*	*10·4*	*8·3*
Re-exports	*0·0*	*0·0*	*0·0*	*0·0*	*0·0*
Newhaven. Total	21·0	18·7	13·5	11·0	7·0
Imports	*13·5*	*13·8*	*8·8*	*7·1*	*3·2*
Exports	*5·0*	*3·6*	*3·5*	*2·6*	*2·2*
Re-exports	*2·5*	*1·3*	*1·2*	*1·3*	*1·6*
Other ports. Great Britain Total	111·6	158·6	164·0	116·4	101·0
Imports	*53·3*	*74·0*	*86·2*	*59·6*	*49·3*
Exports	*57·8*	*82·4*	*74·8*	*53·8*	*49·9*
Re-exports	*0·5*	*2·2*	*3·0*	*3·0*	*1·7*
Ports of Northern Ireland. Total	19·5	28·9	26·4	20·6	16·6
Imports	*17·3*	*21·9*	*18·7*	*14·1*	*11·8*
Exports	*0·7*	*6·4*	*6·6*	*5·5*	*4·1*
Re-exports	*1·4*	*0·6*	*1·1*	*0·9*	*0·7*
Total. United Kingdom	1,403·6	2,034·1	1,974·2	1,315·7	1,237·2
Imports	*768·7*	*1,156·6*	*1,184·0*	*861·3*	*756·0*
Exports	*525·3*	*752·9*	*677·2*	*390·6*	*425·8*
Re-exports	*109·6*	*124·6*	*113·1*	*63·9*	*55·3*

Based on tables in *Statistical Abstract* for the United Kingdom.

III. Export Trade of the Leading Ports Expressed as a Percentage of the Total Export Trade

	1913	1926–30	1931	1935
London	18·9	21·9	22·8	26·2
Liverpool	32·4	32·9	26·9	29·4
Hull	5·6	4·6	5·0	5·8
Manchester	4·0	4·3	3·6	3·0
Southampton	4·0	5·5	5·8	5·5
Glasgow	6·9	7·2	6.6	6·1
Harwich	1·1	0·7	0·9	0·9
Tyne ports	2·5	2·5	3·2	2·6
Dover and Folkestone	1·3	1·0	1·5	1·1
Bristol	0·8	0·5	0·4	0·2
Grimsby	4·2	1·8	1·8	1·2
Goole	2·0	2·0	2·5	1·9
Leith	1·3	0·8	1·0	0·8
Cardiff	3·3	1·9	2·7	2·0
Newhaven	1·0	0·5	0·7	0·5

IV. IMPORT TRADE OF THE LEADING PORTS EXPRESSED AS A PERCENTAGE OF THE TOTAL IMPORT TRADE

	1913	1926–30	1931	1935
London	33·3	39·7	42·5	42·5
Liverpool	22·8	18·6	12.2	18·5
Hull	6·5	6·0	5·9	6·4
Manchester	4·6	5·3	4·7	5·3
Southampton	3·3	3·4	3·3	3·5
Glasgow	2·4	2·5	2·4	2·7
Harwich	3·3	3·5	4·7	2·6
Tyne ports	1·4	1·8	1·9	1·5
Dover and Folkestone	3·2	1·1	1·7	1·2
Bristol	2·3	2·6	2·7	3·1
Grimsby	2·1	1·8	2·0	1·6
Goole	1·1	1·0	1·1	0·6
Leith	2·1	1·6	1·5	1·3
Cardiff	0·9	0·8	0·8	0·7

V. ENTREPÔT OR RE-EXPORT TRADE OF THE LEADING PORTS EXPRESSED AS A PERCENTAGE OF THE TOTAL ENTREPÔT TRADE

	1913	1926–30	1931	1935
London	53·7	59·7	57·6	59·9
Liverpool	23·0	15·4	11·2	11·8
Hull	5·1	1·3	1·3	2·0
Manchester	0·4	0·6	0·8	0·7
Southampton	6·7	9·8	11·6	9·6
Glasgow	0·4	0·9	1·1	0·9
Harwich	2·5	1·5	2·6	2·3
Tyne ports	0·0	0·2	0·2	0·2
Dover and Folkestone	3·7	5·0	4·7	4·5
Bristol	0·1	0·4	0·3	0·5
Grimsby	0·1	0·4	0·1	0·1
Goole	0·1	0·1	0·1	0·1
Leith	0·3	0·2	0·2	0·2
Cardiff	0·0	0·0	0·0	0·0
Newhaven	2·3	1·1	2·0	2·8

inter-relation of geographic and economic factors. In the first place it is true to say that the site of every British port was determined originally by local geographical conditions. The first requirement was the provision of a safe harbourage. In the second place the situation of that safe harbourage or anchorage relative to important parts of the country and the ease of communication therewith played a leading part. Perhaps the first great test of the suitability of an existing port in relation to changing conditions came with the development of inland transport and the Industrial Revolution—the canal era and the concentration of industry on the coalfields—and then again later with the development of the railway age. Where the port was so situated that it could utilise to the full these new means of communication it survived and

VI. THE LEADING BRITISH PORTS. SHOWING NET TONNAGE OF VESSELS CLEARED (MILLIONS OF TONS)[1]

	1913		1926–30		1931		1935	
	Foreign	Coastal	Foreign	Coastal	Foreign	Coastal	Foreign	Coastal
London	11·4	8·6	19·4	7·9	19·4	8·6	19·5	7·8
Liverpool	11·2	4·2	13·0	3·5	11·9	3·7	12·5	2·7
Hull	4·4	1·4	4·4	1·3	4·2	1·3	4·5	0·9
Manchester	1·5	1·2	3·0	1·0	2·7	0·8	2·9	0·3
Southampton	6·6	1·6	10·4	1·5	10·4	1·7	10·7	1·8
Glasgow	4·3	2·0	4·8	1·5	4·3	1·3	4·4	1·5
Harwich	0·9	0·3	2·3	0·1	2·8	0·1	2·8	0·1
Tyne Ports	8·5	3·4	7·4	2·2	7·0	2·3	5·9	4·2
Dover and Folkestone	3·2	0·3	2·8	0·2	3·2	0·3	4·0	0·4
Bristol	1·1	1·6	2·0	1·3	2·1	1·5	2·1	0·9
Grimsby	2·8	0·3	2·0	0·3	2·1	0·3	1·8	0·4
Goole	0·8	0·7	0·7	0·4	0·8	0·5	0·6	0·5
Leith	1·5	0·8	1·5	0·7	1·3	0·7	1·3	0·8
Cardiff	10·4	2·2	7·0	1·2	6·4	1·2	5·3	3·3
Newhaven	0·5	0·2	0·6	0·1	0·7	0·1	0·7	0·2
Swansea	2·8	0·6	3·2	0·6	2·9	0·4	3·2	1·1
Blyth	2·2	0·3	1·3	0·9	0·9	1·2	1·2	2·1
Plymouth	3·8	0·9	6·3	0·5	6·7	0·6	5·2	0·5
Middlesbrough	2·1	1·3	2·4	0·8	2·0	0·5	2·1	1·1
Holyhead (and Beaumaris)	0·0	1·5	1·4	0·7	1·4	0·6	1·3	0·6
Cowes and Isle of Wight	0·0	1·9	2·0	2·1	3·7	2·4	3·8	2·9
Portsmouth	0·1	1·6	0·2	2·0	0·1	1·9	0·1	2·3
Sunderland	2·0	1·5	1·4	1·5	1·5	1·6	1·1	1·9
Belfast	0·3	3·1	2·5	2·9	2·9	3·5	3·2	3·8

expanded. But a still greater test was still to come. Could the port adapt itself to the increasing size of the modern steamship? A harbourage of limited size, a rock-girt basin, a river channel given to silting or difficult and expensive to dredge; these are factors which have resulted in the downfall of once significant ports. Whatever their original advantages, all the great modern ports have had to adapt themselves to changing conditions. Two factors are absolutely essential to this development. The first is the suitability of the site to adaptation, the second the existence of sufficiently wealthy or powerful interests to carry out the actual work of organisation and construction. The one, it should be noticed, is useless without the other. It is significant how often the geographical factor which originally rendered the site of value or of importance as a port, as, for example, the existence of a small safe anchorage or pool at Liverpool and Hull, has become, with the changing requirements of shipping, of very little importance, and it has passed both out of existence and out of knowledge. It will be useful therefore to sketch very briefly indeed the history of each of the major ports of Great Britain.

[1] This table deserves careful study and comparison with those on preceding pages because it brings out the importance of coastal traffic apart from foreign trade and of certain purely "passenger" ports.

LONDON

There is little doubt that London was a port as soon as it was a settlement. Below the site of London the banks of the river Thames were low and marshy and unsuitable for settlement, and we have seen how the settlement grew up where firm ground approached sufficiently near to the river and where there was also a possible fording place. Those who know London at the present day find it hard to believe that the Thames was ever fordable in the neighbourhood, but one must remember that man in the last 2,000 years has consistently been chaining the river into a narrow channel, whereas in early times, especially over what is now the Surrey side, the waters must have wandered over a very wide area, and have been correspondingly shallow. From the early settlement trackways radiated to different parts of the country both to north and to south of the river, and there can be little doubt indeed that the early inhabitants of London had their primitive boats on the river Thames and that London was, therefore, a meeting place of land and water routes and a port. We may go so far as to say that the history of the port of London falls into four stages :—

(*a*) The early period (to the Norman Conquest) ;
(*b*) The medieval period ;
(*c*) The nineteenth century—the great dock building era ;
(*d*) The modern period dating from the establishment of the Port of London Authority in 1908.

(*a*) *The Early Period.*—The well-known Pool of London which at present is situated as it ever was below London Bridge must have afforded an excellent anchorage for ships, and there is certainly no lack of evidence that Londinium was an important commercial centre much frequented by merchants and trading vessels at the time of the Romans. These facts are recorded by Tacitus in A.D. 61. It was natural, therefore, that London should later become the chief town of the East Saxons, and that in the eighth century the Venerable Bede should describe it as a market of many nations whose traders came to it both by sea and by land. Later, London fell into the hands of the invading Danes from whom it was rescued by King Alfred the Great who, by encouraging the building of ships, helped materially the commerce of the port.

(*b*) *The Medieval Period.*—There seems little doubt that London benefited on the whole from the Norman Conquest, for it was brought into closer relationship with the then more advanced countries of Europe. Merchants from France and from Flanders, as well as from more distant countries, came and settled in London and developed the city's foreign trade. The construction of the Tower of London by William the Conqueror illustrates the importance that was attached by the Normans to the stronghold,

Even before the Norman invasion bands of German merchants had settled in what is now the area of Billingsgate, and it was from the descendants of these German settlers that the Hanseatic League developed. The centuries succeeding the Norman Conquest are marked especially by the development of the Hanseatic League and by the stranglehold which it gradually obtained over the commerce and shipping of the port of London. With the discovery of America by Columbus in 1492 the great age of exploration commenced. As early as 1505 the Merchant Adventurers was incorporated, and this association of Englishmen rapidly became a great band of merchant shipowners as well as trading adventurers. The English merchants rapidly became so strong that in 1598 the Hanseatic League was expelled from the country by Queen Elizabeth. The sixteenth and seventeenth centuries witnessed a great development of English foreign trade and with it the development of the trade of the port of London. The Russian Company, the Turkey Company, the East India Company, the Hudson's Bay Company and other concerns came into existence during this period, particularly under the stimulus of promises of monopolies to those companies which first opened up communication and trade with new or undeveloped countries. There is no doubt, too, that London benefited by the sack of Antwerp in 1585, since Antwerp was at that time the centre of European trade, and one is justified in saying that from that event onwards London became the commercial centre of the world. During this time London was a great river port. The small ships were beached or anchored by the side of the stream and their cargoes off-loaded in that position. Later it became desirable or necessary to construct small wooden piers or wharves of stone and wood at which the vessels could lie to be discharged or loaded. The sites of some of these early quays are still marked by quays used for the off-loading of goods, particularly the well known Queenhithe and Billingsgate. Old London Bridge played an important part in limiting the activities of the port. Every one must be familiar with pictures of the bridge with its double line of shops and houses and its numerous narrow arches. The rush of water through the narrow arches, both with the flow and ebb of the tide, was so severe that navigation was virtually limited to small boats and then to short periods of the day when the water was comparatively slack. Thus the port developed below London Bridge, and it is significant that all the great docks of the Port of London to-day are in the area below London Bridge. London Bridge is, indeed, the head of ocean navigation on the Thames to-day just as it was 500 years ago.[1] The Great Fire of London in 1666 destroyed most of the wharf and warehouse accommodation

[1] Except for small colliers and craft of comparable size able to pass under the arches of the bridge.

existing up to that time, and the reconstruction was on improved lines. The quays built were of two types: the legal quays used for general trade, and others, the sufferance quays or wharves, which were subject to conditions enforced by the Commissioners of Customs. It was during the eighteenth century that the greatly

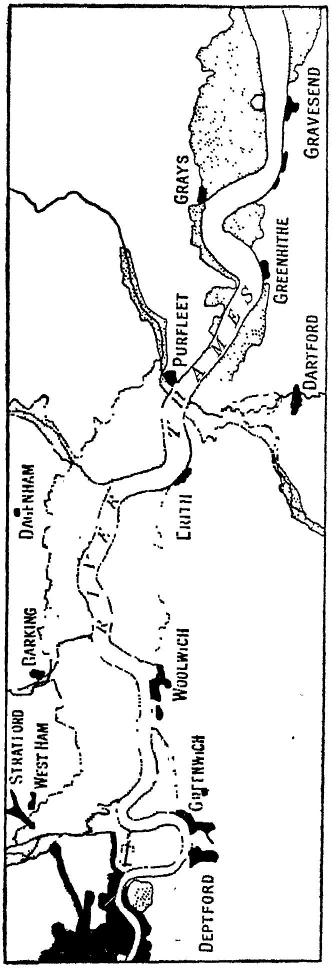


FIG. 265.—Riverside settlements on the Thames below London in 1802.
The stippled area is the alluvial flood plain—practically without any habitations at this date. All the riverside settlements were on bluffs where firmer rocks reached the river side.

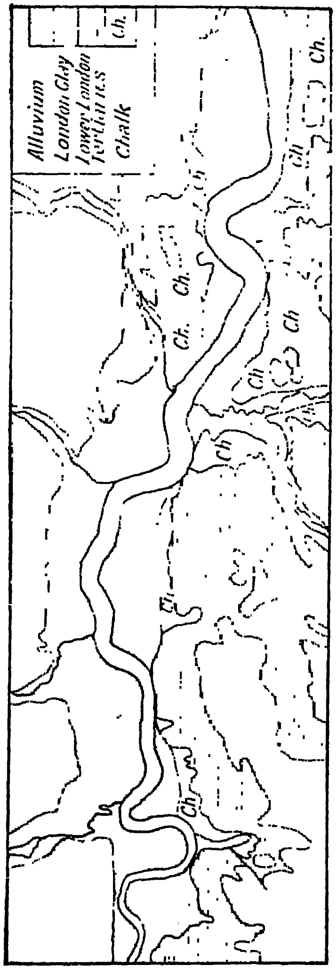


FIG. 266.—The geology of the Thames Valley below London.
Comparing this map with Fig. 265 it will be seen that the majority of the early riverside settlements are where the chalk affords firm ground

increased trade of the port of London demonstrated the insufficiency of the accommodation then available. Continuous congestion of shipping in the river itself resulted in great delay, loss, and inconvenience. It was difficult to protect vessels lying at anchor in the stream from plunder and from smuggling, and smuggling assumed huge proportions. Although a committee was appointed

by Parliament in 1796 to inquire into methods of improving the port, it was the West India merchants who drew up practical proposals for the improvement of conditions. They laid it down as an axiom that any future development of the port depended upon the construction of wet docks.

(*c*) *The Nineteenth Century.*—There was thus initiated the great period of development in the nineteenth century which may be described as the dock building era. The scheme of the West India merchants was to construct two docks on the Isle of Dogs. The plan was sanctioned by Parliament, and the West India Docks were opened on August 27, 1802. They were the first docks as understood to-day to be opened in the port of London. The Howland Dock at Rotherhithe had been opened in 1696, but it was only intended for the safer anchorage of ships and, indeed, trees were planted as far as possible all round it in order to break the force of the winds. What had previously been regarded as the curse of London was now to be its salvation. For below the site of London, stretching practically to the sea and to a large extent along both banks, were enormous stretches of useless marshland, unsuitable alike for settlement and building, and for reclamation by the agriculturalists; this land for the most part had been lying entirely waste. Thus there were huge tracts where enormous docks could be constructed. Further, the land was a soft alluvium easily excavated, and below that gravel and London Clay[1] which also presented little difficulty. The land to start with was at river level. The London Clay did not present difficulties in the construction of docks which a very pervious substratum might have done; but at the same time the solid clay was sufficiently firm for the

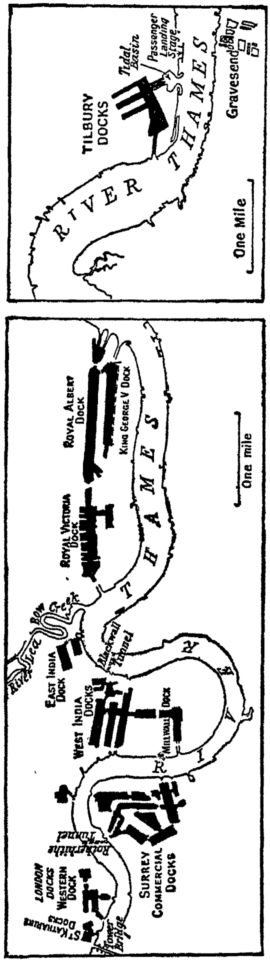


FIG. 267.—The docks of the Port of London.

Comparing this map with Figs. 265 and 266 it will be seen that all the docks have been excavated in the previously uninhabited flood plain in the tracts of alluvium

[1] But chalk at Tilbury.

foundation of quays and warehouses and, later, for great buildings such as flour mills. The success of the West India Docks initiated the great period of dock construction. The London Dock was opened in 1805, the East India Dock in 1806, the St. Catherine Dock in 1820, the Royal Victoria Dock in 1855, the Millwall Dock in 1854, and the Royal Albert Dock in 1880. That curious collection of docks, now known as the Surrey Commercial Docks, came into existence piecemeal between 1807 and 1876. At a later stage came the construction of what is really the outport of London, Tilbury Docks, which were opened in 1886. In addition to the docks there were numerous riverside wharves and warehouses. The docks, warehouses, and wharves were built and owned by different companies. There was little co-ordination; instead destructive competition was the usual rule. Companies found themselves with insufficient resources to carry out the improvements and re-construction which the growing size of steamers demanded. Towards the close of the nineteenth century there was a very real danger that London might pass into the position of only a second-class port.

(*d*) *The Modern Period.*—But the danger passed, when, it is true after a considerable delay, Parliament passed the Port of London Act in 1908. This act created a new authority, a public trust—the Port of London Authority—which was to take over and administer all the docks and the whole of the tidal portion of the River Thames between Teddington (literally tide-end-town) and an arbitrary line about 70 miles to the east across the estuary. The P.L.A., as it is usually called, has thus jurisdiction over the docks and their associated warehouses and storage yards, but on the main river itself the limit of the Authority's jurisdiction on both banks of the river is the high-water mark. Thus there are numerous quays and wharves lining the river which are privately owned, the best known of which is perhaps Hay's Wharf. In the river itself the duties of the Port Authority include all matters relating to navigation, regulation of traffic, and the maintenance of adequate river channels; and undoubtedly one of its most important works has been the improvement of the river channels. In 1909, just after the Port of London Authority took charge, the deepest draughted vessel that had used the Port of London up to that time drew 27 feet of water. Now vessels which draw up to 37 feet, the normal draught of the largest vessels in the world, can use the port of London. There is, indeed, a good navigable channel a thousand feet wide with a general depth of 30 feet at mean low-water spring tide from the Nore to Coldharbour Point, a distance of 35 miles. From the latter point to the Royal Albert Dock, another six miles, the channel is 27 feet deep and 600 feet wide, whilst fairly large sea-going steamers can ascend right to the Pool of London, to London Bridge.

We can now proceed to examine some of the outstanding features of the Port of London. One of the most remarkable features is undoubtedly the extensive use of lighters or barges. Despite the enormous area of wharfage accommodation, something like four-fifths of all the cargo reaching the port of London is off-loaded into lighters or barges, of which there are some 9,000 on the waters of the Thames. The owners of these lighters or barges still have the rights which were given to their predecessors when the first docks were sanctioned by Parliament. They can enter or leave any of the docks belonging to the Port of London Authority without payment of any special dock charge. They are continually plying between the docks and wharves and the factories which line the 170 miles of banks of the river Thames. Most of these barges are towed by steam tugs. Only a few of the old sailing barges remain, whilst a comparatively small number are as yet self-propelled. There is little sign that this system of off-loading into lighters will disappear; for the construction of gigantic new works, such as the Battersea Power Station [1] well above London Bridge, will involve the continued use of the barges. In the second place London illustrates remarkably well that the successful modern port must not only be well equipped for handling all types of general cargo, but must have the special equipment necessitated by special types of cargo. It is one of the features of the London docks that there is marked specialisation in the cargoes handled by the principal docks. Then there is no doubt at all that the Port of London derives an enormous benefit from its huge storage accommodation, for it enables the Port of London Authority to act as warehouseman, more especially of goods which are subjected to heavy customs dues. Merchants and wholesalers can rent storage space in the Port of London Authority's warehouses, or can pay so much for the storage of goods, and thus defer the payment of customs duty until the goods are actually required and can be cleared. Thus enormous quantities of tobacco are normally stored. Further, there are facilities for the cold storage of meat and other commodities requiring very specialised storage conditions unrivalled by any individual firm. For these reasons London has a virtual monopoly of several types of imports into the country. The following table shows the percentage of different imports into the United Kingdom which were handled by the port in 1929:—

	Per cent.		Per cent.
Meat	48·0	Tea	93·0
Grain and flour	24·0	Non-ferrous metals	38·0
Cotton	1·5	Iron and steel	22·0
Wool	45·0	Hides and skin	43·0
Butter	44·0	Paper	50·0
Wood	30·5	Eggs	40·0
Mineral oil	50·0	Tobacco	30·0
Vegetable oils	35·0	Rubber	80·0

[1] Coal is now being delivered direct from colliers.

with at the West India Docks are still sugar and rum. Here it is interesting to note other functions carried out by the Port of London Authority. Samples of sugar are taken by their experts, and the sales in the City are based on these samples which are in a way guaranteed by the independent and unbiased Port of London Authority. Hardwood and paper are the other chief commodities handled by the West India Docks. The Millwall Dock specialises in the handling of grain, and it is here that the grain is sucked from the holds of vessels by pneumatic elevators and passed into the central granary, which with a capacity of 24,000 tons holds sufficient grain for London's needs for at least a week. Farther downstream the East India Dock still handles large quantities of goods from the East, particularly tea and silk; but it is here also that special arrangements have been made for the banana traffic of London. Here, too, there is a disease-proof quarantine station established for pedigree stock for export to various parts of the world. The Royal Victoria, Albert, and King George V Docks are in reality one huge dock divided into three sections. They form the largest sheet of enclosed dock water in the world, with a total area of 1,100 acres, of which 245 acres are water, and with $12\frac{3}{4}$ miles of quay. In these docks the water is kept at a height of $2\frac{1}{2}$ feet above high-water mark. To the north of the Royal Victoria Dock are the storage warehouses, whilst to the south are the two largest flour-mills in London. The Royal Albert Dock handles much of the meat imported by London, the meat being taken through covered ways into a huge cold store which has been erected to the north side of the dock, and which is capable of accommodating a quarter of a million carcasses of mutton. The King George V Dock was not opened until 1921, and, with a depth of 38 feet, it can accommodate vessels up to 30,000 tons gross, despite the fact that it is comparatively near to the heart of London. The largest vessels in the world can be accommodated in the Tilbury Docks, where a new entrance 1,000 feet long and 110 feet wide was opened in September 1929, and where a magnificent new dry dock has also been recently completed. Tilbury handles most of the passenger traffic using the port of London, and there is a floating jetty which can be used at all stages of the tide. It is served directly by the London, Midland and Scottish Railway, and is within 35 minutes of the heart of London in addition to having easy communication with all parts of the country. Improvements in the passenger facilities were made here in 1930, and are indicative of the great progress still being made in the Port of London.[1]

We have indicated elsewhere how the once significant shipbuilding industry of the Thames has disappeared, and London

[1] Tilbury might have developed into a separate "outport" and rival of London itself, but the unification of control has prevented this.

illustrates rather well the separation of shipbuilding from ship repairing. The Port of London is very well equipped for ship repairing. It has no less than ten dry docks, including one at Tilbury which is 750 feet long and 100 feet wide and can, when the increasing size of vessels demands it, be extended to over 1,000 feet in length. In these docks every facility for the repair and overhaul of vessels is provided. Amongst items of general equipment which are so essential for the progress of a modern port one may mention arrangements for lifting. The Port of London boasts many gigantic floating cranes, including the London Mammoth capable of lifting 150 tons. One very important factor in the maintenance of London's pre-eminence as a port is the close co-operation

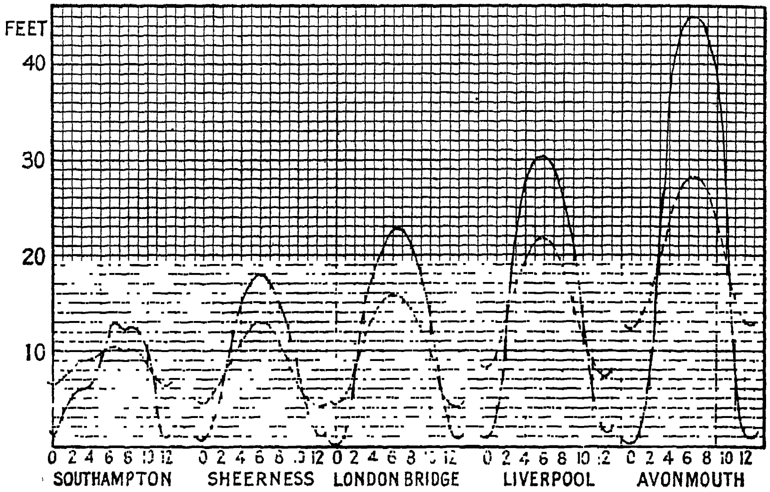


FIG. 269.—Tidal graphs of some characteristic British ports.

The two graphs in each case are for a typical spring tide and a typical neap tide. Figures below show the time in hours. Notice the effect of the double tide at Southampton and the small range; the increasing tidal range in the Thames as one goes from Tilbury to London Bridge; and the enormous range at Avonmouth.

between the port and the commercial centres of London. This is possible despite, in fact one might say because of, the separation of London into zones of functional utilisation Thus going westwards from dockland one comes immediately to the commercial and business centre of London—first to the network of narrow streets where are situated so many of the wholesale firms. Mincing Lane, for example, is associated particularly with the trade in tea and various tropical products. This juxtaposition is responsible for the retention in London of a great woollen market—for so long and to some extent even now a world market—despite the fact that practically none of the wool is used for manufacture in the neigh-

bourhood of London itself. Then there is the very close connection between the Port of London and industrial London. On p. 609 we have given a map showing the situation of so many of London's

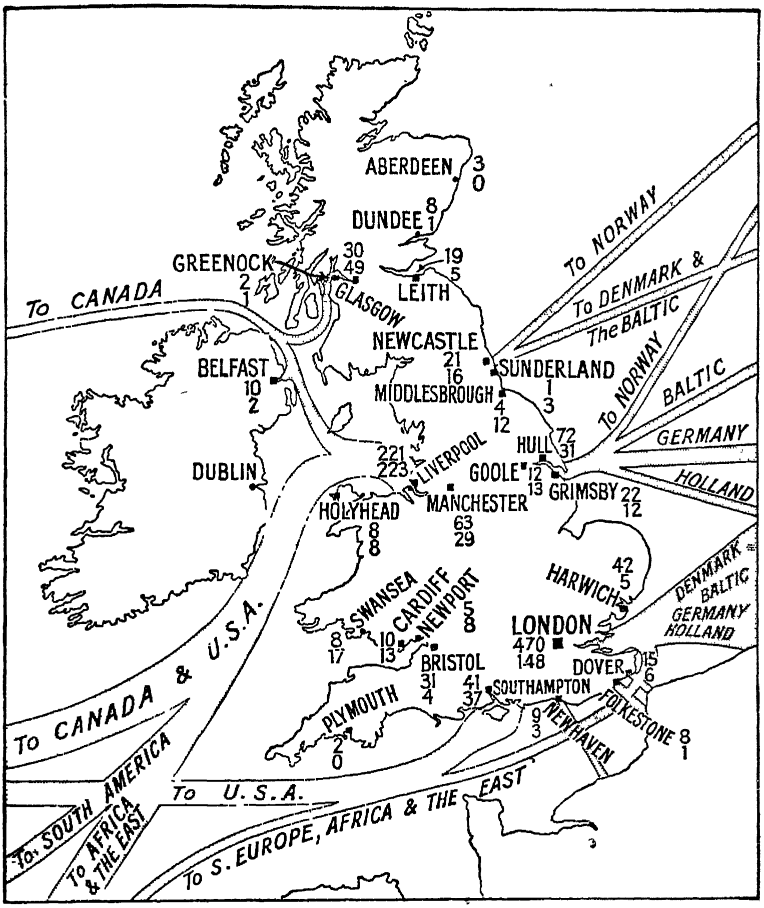


FIG. 270.—General map of the Ports of the British Isles showing the average value of the trade of each.

Upper figures represent imports; lower figures exports (in millions of pounds sterling, average of the years 1927–31 in each case). Some attempt is made to show the countries *principally* served by each port.

industries along the banks of the Thames, and it is the system of lighters that enables immediate contact to be established between the docks and these waterside industries.

LIVERPOOL OR MERSEYSIDE [1]

If London has been a great port for 2,000 years the same can scarcely be said of Liverpool; for the real rise to importance of Liverpool is within the last two hundred years. A thousand years ago, when London was already an important centre, Liverpool was just one of a group of small vills comprised within the ecclesiastical parish of Woolton in the Greathundred of West Derby. Both sparsely inhabited and comparatively unimportant was the region at the time of the Domesday Survey, hence (because of its unimportance) the hundred of West Derby is one of the largest in the country. The greater part of the old parish of Woolton was situated on an island-like upland, formed of Keuper and Bunter Sandstone, which Professor P. M. Roxby has called the Liverpool Plateau. It was almost surrounded by low-lying land, originally "mosses" or low-lying peatland which cut it off from the rest of Lancashire. North-eastwards a ridge of slightly higher land connected this island-like site with South Lancashire through Prescot, and for a very long time the only carriage road lay along this ridge. To the south-west the plateau approached very close to the bottle-necked estuary of the Mersey. Liverpool was an agricultural township, but it had the advantage of a small tidal creek called the Pool which extended inland for about half a mile from the site of the Customs House along the line of what is now Paradise Street and Whitechapel as far as the old Haymarket. King John seems first to have visualised the possibilities of Liverpool as a port for Ireland—a military port in that case—and so made it into a borough in 1207. And it was from the quiet waters of the Pool that fishing and coastal traffic was built up, including a not inconsiderable trade with Ireland. But in these early days Liverpool was overshadowed by the importance of Chester. Indeed, it was claimed as being merely a creek within the port of Chester. But, owing to the silting up of the Dee estuary which was specially marked from the fourteenth century onwards, Chester became unimportant as a port even before the rise of the trans-Atlantic trade which was destined to be of such significance to Liverpool. The great age of exploration initiated by the discovery of America in 1492 first gave Liverpool its real opportunity, but for long Bristol dominated in the western trade. There seems little doubt that the greater security of a route to the north of Ireland compared with the route to the south of Ireland was by no means unimportant in view of the long series of wars with Holland and France in the seventeenth and eighteenth centuries. Although the immediate

[1] It should be noticed that the Merseyside ports are served by three great English railway systems—the G.W. to Birkenhead, the L.M.S. and the L.N.E.R. to Liverpool itself, the L.M.S. having its own port at Garston.

situation of Liverpool rendered communication with its hinterland in Lancashire difficult, the importance of the Midland Gate which facilitated communication between the merchants of London and Liverpool soon came to be recognised. From the latter part of the seventeenth century the growth of the port was rapid. First came the recognition of Liverpool as the chief port for the Irish trade as far as the north of England was concerned, as well as for increasing coastal traffic with western Scotland. Then there was the rapid development of trade with the West Indies, unfortunately associated from about 1730 with what has come to be known as the great Trade Triangle and which dominated Liverpool shipping in the latter half of the eighteenth century. Ships from Liverpool sailed to West Africa with cheap manufactured goods such as beads, indifferent muskets, gunpowder, and raw spirits which they traded with the native slave-traders or so called "kings," who organised slave raids into the interior. These same ships then took on board full cargoes of negroes and made the famous middle passage with the help of the Trade Winds, disposing of the slaves in the West Indies, returning thence to Liverpool with a cargo of molasses, tobacco, and cotton. The abolition of the slave trade in 1807 did not, as many Liverpool merchants had anticipated, check the growth of the port. By that time the Industrial Revolution was in full swing, and there was a huge demand for raw cotton from the southern United States, and Liverpool became what it has since remained—the chief importing port for raw cotton. Then came the development of trade in cotton goods, particularly after the cessation of the monopoly of the East India Co., as well as the development of more varied trade with the North American continent and an emigrant traffic.

Just as in the case of London, it was found that Liverpool was so situated that she was able to adapt herself to changing requirements. The mouth of the old pool was converted into a wet dock—one of the first in the world—and the remainder of the pool filled in. There was a marshy fringe running along the side of the Mersey and bordering the sandstone plateau on which the settlement was situated, and this afforded possibilities for the excavation of docks just as the marshy land of the lower Thames had done. The docks were extended all along the water front southwards until the natural limit was reached where there is an outcrop of sandstone on the river bank at Dingle Point. Here is the residential district of Aigburth. Beyond this, however, are more marshes, and here has been developed the group of docks forming the port of Garston owned by the London, Midland and Scottish Railway. To the north of Liverpool the limit has not yet been reached, and here it is claimed that the new Gladstone group of docks is amongst the largest and best equipped in the world.

But the development of docks along the whole water front has had two main results. The old shipbuilding yards have disappeared, and not only have the warehouses and mills been forced inland, but still more has industrial development. The factories of Liverpool cannot be supplied direct from lighters as in the case of London or Hull, and so lighters play but a small part in the life of the port. Whilst the excellent arrangement in the port itself renders loading and off-loading possible in very short time, the facilities for the

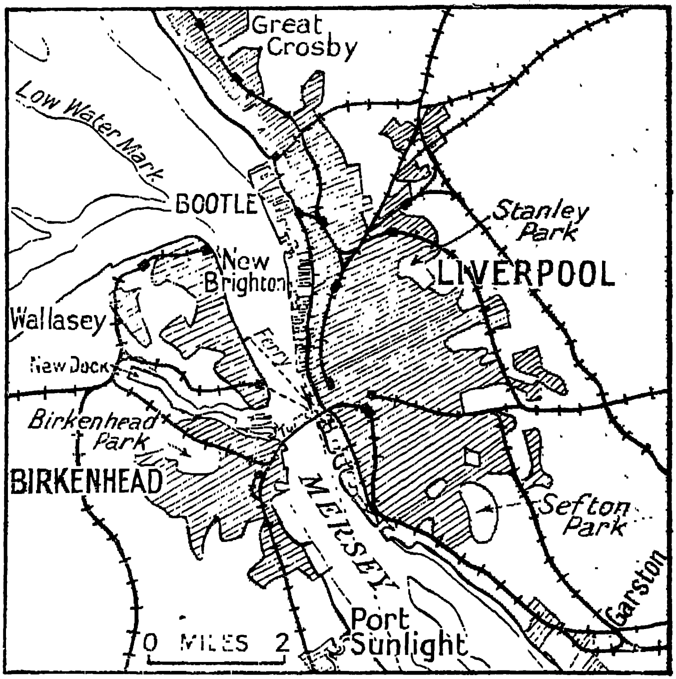


FIG. 271.—The port of Liverpool in 1933. The Wallasey Pool dock system is still in course of completion.

A unique feature of Liverpool's transport system is the electric overhead railway, supported on wrought-iron columns about 20 feet from the ground. It runs for 6½ miles alongside the docks, from Seaforth to Dingle, thus affording exceptional facilities for travelling from one part of the long dock estate to another. It is shown above along the dock front. The new road tunnel, which cost over £7,000,000 and was opened in 1934, lies immediately to the north of the railway tunnel.

development of industries are not correspondingly great. As in London the early dock construction was carried out by separate companies; but the need for a unifying authority was appreciated much earlier, and the Mersey Docks and Harbour Board came into existence in 1858. It now controls the whole dock estate on both sides of the river. The rapid development of the whole water front of Liverpool rendered the utilisation of the Cheshire side inevitable, and it came about the middle of the nineteenth century

—about the initial nucleus of Wallasey Pool, an inlet corresponding roughly in character with the old Liverpool Pool. There are now (1937) 475 acres of docks on the Liverpool side with a quay frontage of 29 miles, and on the Cheshire side a water area of 172 acres and 9 miles of quay. There is not as yet a continuous line of docks on the Cheshire side as there is on the Liverpool side, and so a considerable number of industrial concerns there have their own water frontage. There one finds also the shipbuilding yards, particularly those of Cammell Laird & Co. Thus, on the Cheshire side, there has grown up the great industrial and commercial town of Birkenhead, and more recently the residential area known as Wallasey, which may fitly be described as the dormitory of both Birkenhead and Liverpool. Immense numbers of workers cross over morning and evening by ferry and by the Mersey railway from the Cheshire to the Lancashire side, and the need for the construction of the new Mersey road tunnel soon became apparent.

It has been pointed out that the Liverpool plateau is separated from the main part of Lancashire by a belt of low-lying "moss." A large proportion of this is now fertile agricultural land. Some of it is reserved in the form of parks which form the outer fringe of Liverpool. Both types of utilisation tend to emphasise the isolation of the Liverpool region from the manufacturing and industrial regions of south Lancashire. This isolation is borne out by the character of the industries of Merseyside. For the major industries are based essentially on imported materials—milling, soap, and candle manufactures, cattle-food industries, and so on. Liverpool shows to some extent the zoned character of London. In the rear of the docks there is the business part of the city, concentrated especially round the Town Hall and coinciding very closely with the centre of the old township. Near at hand is what may be described as the social centre with fine public buildings such as the Picton Library, St. George's Hall, the Walker Art Gallery, and many of the finest shops. Then, forming an irregular ring, is the residential area, much of it consisting of extremely congested slums—a legacy of the early days of the Industrial Revolution which Liverpool has done her utmost to remove. On the outer margins there is a ring of great public parks. The industrial development tends to be concentrated near a labour supply, and as far as possible near the supplies of raw materials from the docks. In some cases the industrialisation is considerably removed from the centre of the city, as in the Aintree district. On the Cheshire side lie two main areas of industrialisation. One is to the south of Birkenhead on low-lying ground where there is the industrial area of Port Sunlight and the region around the comparatively new Bromborough Pool, or Bromborough Port, from which continual industrial development to the entrance of the Manchester Ship Canal is likely. The second

area is on the Great Float, the lower part of Wallasey Pool, where the Mersey Docks and Harbour Board have a large amount of land available for future development.

It is possible that the future will see the development of docks and industrial areas along Deeside; in fact there is already considerable development of this sort on the Flintshire or North Wales side of the Dee estuary. The ships owned at, or sailing from, Liverpool provide employment for roughly a quarter of all the seamen of Britain, whilst Liverpool rivals Southampton as the premier passenger port of the British Isles, handling about 30 per cent. of the passenger traffic. A table is given here to show the principal imports of the port.

PERCENTAGE OF U.K. IMPORT TRADE IN VARIOUS COMMODITIES HANDLED BY LIVERPOOL (AVERAGE 1927–31)

	Per cent.		Per cent.
Meat	18·7	Tea	1·1
Grain and Flour	16·2	Non-ferrous metals	26·1
Cotton	74·6	Iron and Steel	6·2
Wool	15·7	Hides and Skins	56·3
Butter	2·4	Paper	4·1
Wood	12·2	Eggs	4·9
Mineral Oil	5·9	Tobacco	33·3
Vegetable oils	17·8	Rubber	15·6

HULL

Hull is an example of a port whose commerce has been continuously active, and whose position in relation to other English ports has changed very little since the Middle Ages. In this respect Hull can be compared with London. Again, we have an example of a port where geographical surroundings permitted its adaptation to modern conditions—as in the cases of London and Liverpool. By way of contrast other ports of the vicinity were not so fortunate. In the thirteenth and fourteenth centuries the commerce of Boston, which was the outport of Lincoln, exceeded that of Hull, but is now entirely insignificant. The possibility of development was precluded for one reason by the silting up of the approaches to Boston. The port of Hedon flourished in the twelfth and thirteenth centuries and stood, like Kingston-upon-Hull, on a tidal creek of the Humber to the east of Hull. But it was too far inland for the approach of modern vessels and suffered, again, from the choking of its channels. Finally, Ravenserodd, formerly situated on a small sandbank behind Spurn Point, entirely disappeared in the middle of the fourteenth century—a victim of the tidal scour which somewhat earlier had created the very land on which it was built.

The little river Hull enters the Humber from the north just where the line of the Humber curves northwards in such a way that the river current and the tidal current hug the shore and

guarantee permanent deep water. The river Hull is navigable for some distance to the north, and, as is so frequently the case, near the head of navigation a small port and town sprang up—the town of Beverley—situated some distance away from the marshy banks of the river itself with which it is connected by an artificial channel. The first stage in the history of the rise of the port of Hull was when the little creek offered shelter or anchorage for boats on their way to its older neighbour Beverley. A little marsh-surrounded settlement grew up to the immediate west of the mouth of the creek, and it was Edward I who, in passing through this little settlement, caused it to be known as King's Town upon Hull (Kingston-upon-Hull is still the full name of the city of Hull), and granted the town its first charter. A plan of Hull dating from the fourteenth century shows a small settlement with quays on the east at which sailing boats are being unloaded with the help of hand cranes, and the settlement guarded on the north, west, and the south by a wall outside of which is a moat connecting the waters of the Hull with the waters of the Humber to the west of the settlement. A glance at a physical map will show that Hull is situated on the Humber just to the east of the point where that river cuts through the chalk escarpment. To the west, the north-west, and the south-west lies the Trent and Ouse Basin: in all covering an area of about one-sixth of the whole of England. Most of the rivers of the basin were navigable for considerable distances. Doncaster was about three miles above the old limit of navigation of the Don and York lies near that of the Ouse. Thus, in early days, a place of shelter near the mouth of the Humber could not compete with the ports which were situated well inland along these navigable rivers.

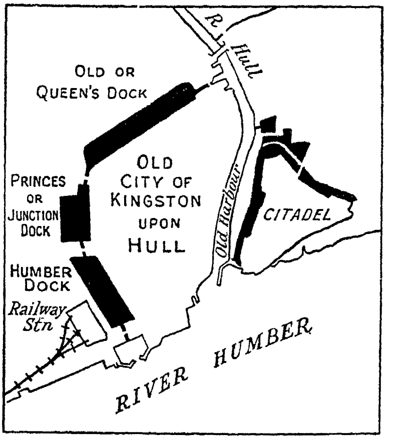


FIG. 272.—The port and docks of Hull in 1840.

The second stage in the development of the port came with the increasing size of ocean-going vessels. Hull became the point of transhipment for river craft trading with towns on the navigable parts of the Ouse and Trent system. It clearly had the advantage of position, and could fulfil this function in a way in which Beverley could never do. So Beverley gradually became what it is to-day—a small town constructing trawlers for the fishing industry of Hull.

The appalling condition of roads in England gave Hull a very considerable importance as an outlet from all central England, even for goods from such areas as Cheshire and Lancashire destined for London.

The third stage in the development of the port came with the canal era, when the natural waterways were improved by a network of canals, of which the Aire and Calder was, and remains, the most important, which brought the growing industrial centres, particularly of West Riding, into easy communication with Hull. Thus the outstanding features of the port of Hull to-day—especially the immense amount of transhipment into lighters for distribution—developed at an early date. Further, Hull is still unique amongst the ports of the British Isles in the extent and significance of inland water navigation from its docks.

The fourth stage in the development of the port came with the construction of docks. As Rodwell Jones has said, "the increase in size of vessels together with the increasing volume of trade made it necessary to supply means whereby ships could be in harbour for considerable periods without grounding, and cargoes could be dealt with at quaysides without change of level, since the tidal range at Hull is about 19 feet." The old wall and moat became the site of the earliest docks. The Queen's Dock [1] or Old Dock was opened in 1778, Humber Dock in 1809, Princes or Junction in 1829. The coming of the railway is emphasised by the name Railway Dock—a small offshoot from the Humber Dock opened in 1846. The earlier line of approach to Hull by railway (from Selby, opened in 1840) followed along the Humber where there was sufficient space between the chalk scarp and the river to obviate the necessity of constructing a tunnel. A later line which approached the town from the north-west had to cross the chalk scarp; the gradients are considerable, and there is also a tunnel. Marshy, unoccupied land to the south-east of the town has provided further opportunity for the construction of docks, and there followed here the Victoria Docks (1850). Subsequent dock construction resembled that at Liverpool in that it extended along the extensive water fronts; but it differs somewhat in the methods adopted. For farther to the south-west the work was carried out by constructing a great embankment along the line of the estuary and thus producing behind it the St. Andrew's Dock (1883), the Albert Dock, and William Wright Dock (1869), these three being to the west of the town. Of necessity, later development had to be further downstream, where there is the giant Alexandra Dock opened in 1886, and the King George V Dock opened in 1914. At first it is to be noticed that railway construction merely emphasised the existing lines of communication, and amongst the early disconnected portions of railway constructed, that from

[1] Which has now outlived its usefulness and has been filled in.

Hull to Selby, and the industrial West Riding, was both noteworthy and early.[1] Subsequent railway construction extensively widened the hinterland served by the port. It is interesting in this connection to notice that with the re-grouping of British railways in 1923, Hull became pre-eminently the port of the London and North Eastern Railway. Turning to the present day trade of the port—the value of that trade does not afford a very good index of its importance because of the great bulk of the coastwise traffic enjoyed by Hull, and the huge fish traffic. Since the fish comes from British waters it does not figure as an import. The port resembles London in the very general nature of cargoes handled, and in that it is primarily an importing port, particularly of foodstuffs. Hull is the leading British port for the import of oilseeds. The seed is sent by lighters from the deep water docks to the crushing mills along the Hull itself and also to the huge mill at Selby. From these mills the

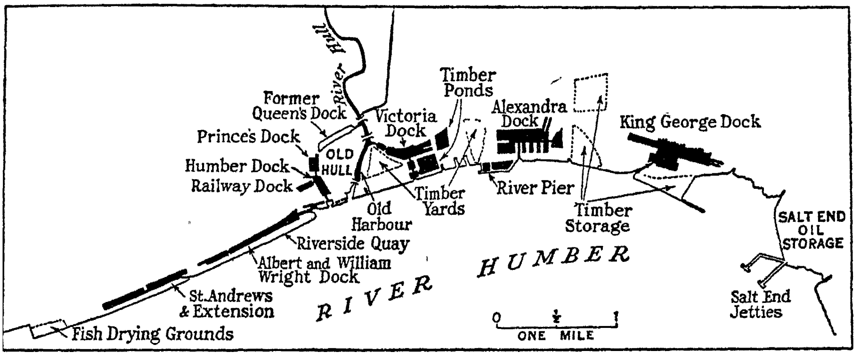


FIG. 273.—The port and docks of Hull in 1933.

cattle food cake, fertilisers, and oil are widely distributed to all parts of the kingdom. Similarly with wheat, of which there is a huge import; one finds flour-mills (with the seed-crushing mills) lining the banks of Hull for something like two miles. Large quantities of wheat are also taken by water to the mills at Selby and York.[2] The concentration of flour milling at the great ports of the British Isles is a very marked feature and has been responsible for the decay of milling in many small towns. There is a very great import trade in butter and bacon—obviously connected with Hull's suitability for distributing these commodities to the large industrial population of the north of England, and also obviously connected with the situation of Hull opposite the Continental ports, including those of Denmark, from which these commodities are exported. Similarly with the huge imports of timber—partly the result of the connection of the port with the great coalfields, and partly because Hull faces

[1] See Fig. 250.

[2] The flour mills at York are now closed.

the European countries from which so much of the timber is derived. What is anomalous is that Hull is only third amongst the importers of wool, for it is obviously the port of the woollen region of West Riding. London is still the great wool market and most of the wool is imported into London. But from here much of it goes by coastal steamer to Hull, but does not appear in the foreign trade of Hull (see p. 459). Hull occupies quite an important position in relation to the hidden eastern extension of the Yorkshire coalfield, and is likely to develop with that field. Something has already been said of the immense importance of Hull as a fishing port. The majority of Hull trawlers are big vessels, often absent for three weeks at a time, and therefore requiring large stocks of coal and ice, and really excellent facilities for handling the catch when they reach port. The St. Andrew's docks are entirely given over to this traffic. Further, trawlers from Hull may land their catch direct in London at Billingsgate, or loosely packed in barrels in salt and ice at Belgian and other continental ports. As in many large ports refineries for mineral oil have been established—at Salt End.

GRIMSBY, including IMMINGHAM and GOOLE

It has been pointed out that the development of Hull as a port is closely bound up with its extensive hinterland and the waterways therein. It is clear that, provided deep-water facilities for ocean going vessels are available, there must be other sites on or near the mouth of the Humber which could equally well handle the traffic of the same hinterland. There are now three ports which share with Hull the Humber trade—Grimsby, Immingham, and Goole. Grimsby lies to the south of the estuary of the Humber in the county of Lincolnshire, 17 miles south-east of Hull. The potentialities of the site have long been apparent, but the development of latent possibilities was left to the railways in the 'fifties of last century when the initiative of the Manchester, Sheffield, and Lincolnshire Railway, now part of the London and North Eastern system, commenced the transformation of a fishing village into a town of over 100,000 inhabitants. Grimsby is, of course, pre-eminently a fishing port, handling a quantity of fish which in post-war years has reached nearly a quarter of a million tons. There was a steady development of the fish traffic in the latter part of last century, but it was not until 1900 and the opening of No. 2 Fish Dock that an enormous extension of the fish trade took place, and now the fish expresses to all parts of Great Britain are a characteristic feature of the port. Of the foreign trade, timber is one of the most important commodities catered for at Grimsby. The Alexandra Dock in particular has huge floating space for timber and extensive storage yards. A large proportion of the import is of pitprops, and there is a corresponding export in the trade in coal. There is

also an import of iron ore, and facilities exist at the port for the handling of pig-iron and wood pulp. But the entrance to the Grimsby Docks is through a tidal basin and the largest lock is a 70-foot lock. The main channel of the Humber does not swing along the coast here and there is a huge stretch of mud at low tide. Five miles to the west of Grimsby, however, there is a position where the main channel of the Humber approaches the shore. Here Immingham Dock was constructed and opened in 1912. The entrance lock is 840 feet long, 90 feet wide, and has a depth on the sills at mean low-water spring tides of 28 feet. The port is specially

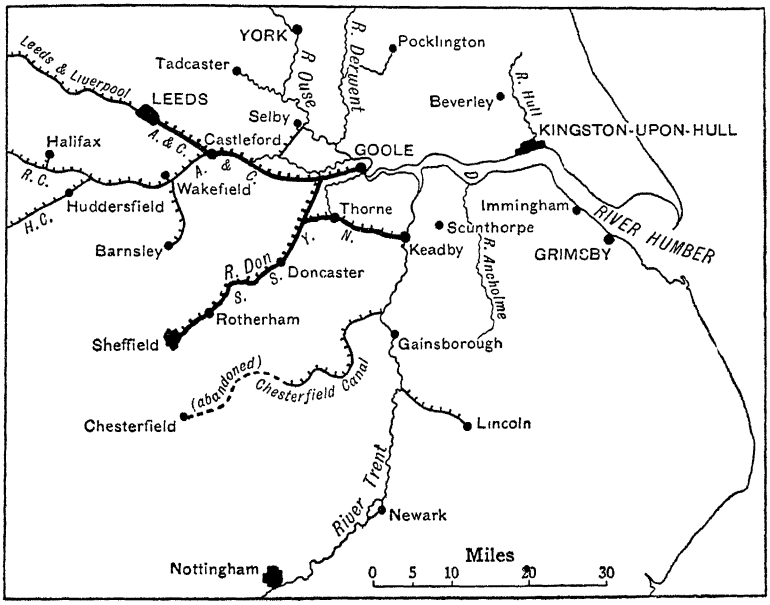


FIG. 274.—The Humber Ports.

Showing water-connections with the hinterland, especially by the Aire and Calder Canal (A. & C.). All waterways marked are navigable (compare Fig. 249).

concerned with the shipment of coal, and the import of pitprops and other timber. Grimsby and Immingham, both on the London and North Eastern Railway system, have an important rival in Goole which, though owned by the Aire and Calder canal with which it originated, is the corresponding port on the London, Midland and Scottish system. Goole is directly connected with Leeds by the Aire and Calder canal system, and there are express chains of barges using this canal—now one of the most important inland waterways in the kingdom. Excellent facilities exist at Goole for coal shipment and for the import of timber, iron ore, and similar bulky commodities. It has some direct near-continental trade.

MANCHESTER

As an ocean port Manchester only dates from January 1st, 1894, when the Manchester Ship Canal, constructed between 1887 and 1893, was opened for traffic. The Manchester Ship Canal extends from Eastham on the south side of the Mersey to the heart of Manchester,[1] and has a total length of 35½ miles and a minimum depth of 28 feet. There are three entrance locks at Easton, the largest of which is 600 feet long and 80 feet wide, and the bottom width of the canal at the full depth is, with a very few exceptions, 120 feet. This is sufficient to allow large ships passing one another, and at the bend at Runcorn the bottom width has been increased to 155 feet. In 1894, the first year that the port of Manchester was opened, the value of the trade was £6·9 millions sterling, of which about 40 per cent. represented imports. The trade had grown tenfold in value by 1929. The capital expenditure on the canal by the end of 1914 was nearly £17 million, and it was not until 1915 that the first dividend was paid on the preference stock. The canal passes through one of the busiest industrial regions of the British Isles, and eventually the whole 70 miles of its two banks may be destined to form a line of quays. The development of the port has not adversely affected the development of Liverpool. One may even go so far as to say that it has acted as a safety valve. Only in the case of one or two commodities does the quantity landed at Manchester exceed that landed at Liverpool; of these one is petroleum—obviously destined for the refineries along the canal itself. Manchester still only handles one-third of the quantity of raw cotton imported by Liverpool (see p. 487), but the proportion handled has increased.

SOUTHAMPTON

Southampton is the chief commercial port on the south coast, and though it is one whose commerce and shipping dates back to a very early date the modern port is essentially a product of the railway era. A Roman station existed at Bitterne just to the east of the Itchen estuary, and nearby on the small tongue of land between the mouths of the Itchen and the Test the town and the docks of Southampton are situated. Southampton has two great natural advantages. One is the deep, wide, and sheltered approach to the port through Southampton Water, which has a depth of water at low tide of at least 35 feet, and in places as much as 80 feet. The combined discharge of the rivers Itchen and Test is only about one-thirtieth of that of the Thames, and Southampton Water is not, therefore, strictly the estuary of these rivers; it is a drowned valley. For the most part the depth of the channel is natural and only a

[1] The docks are actually in Salford, but cf. p. 575.

comparatively short length has been improved by dredging. Large vessels approach Southampton Water through Spithead, round the eastern end of the Isle of Wight, because at the entrance to the Solent (see Fig. 275) between the Needles and the Hampshire coast there is an impeding bank of shingle which is increased in size during south-westerly gales. Although the rush of the tide prevents the blocking up of this entrance, it is avoided by larger vessels. The second great natural advantage of Southampton is the curious phenomenon of double high tides. A second high-water occurs about two hours after the first. Between the two high-waters the tide falls but slightly, and so that in reality high-water is prolonged for about three hours. This is of the utmost value in manœuvring

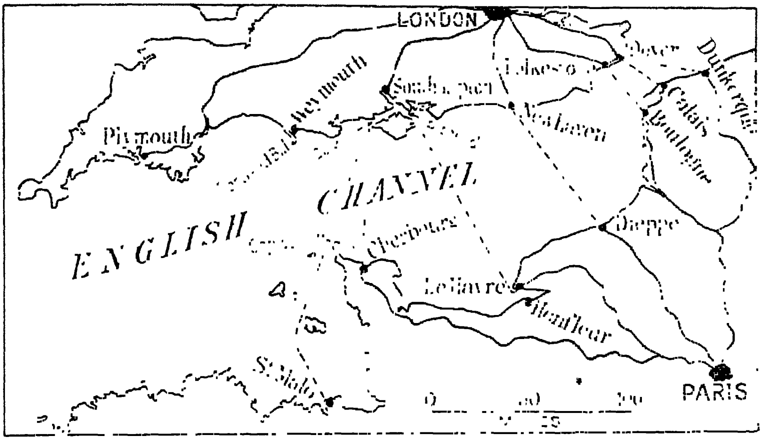


FIG. 275.—The position of the port of Southampton relative to the English Channel, showing the narrowing between Cape de la Hague and Portland Bill, which is believed to cause the double tides of Southampton.

The principal cross-channel routes between Britain and France are also shown. (*Note*: the Southern Railway initiated a train-ferry service from Dover to Dunkerque in 1936 permitting through coaches from London to Paris.)

a very large ship into dry dock—a process which occupies at least an hour and perhaps more, and calls for quiet water while it is being carried on. It is believed by some that the double tide is caused by one tide approaching through the Solent past the Needles, the other coming round the eastern side of the Isle of Wight. But it is found that places as far away as Weymouth as well as places on the far side of the Channel, as at Honfleur, also have this double tide; and it is now more generally believed to be due to the constriction of the Channel as shown in the diagram (Fig. 275). Despite its natural advantages the port developed but little until the middle of the nineteenth century when two famous engineers—Francis and Alfred Giles (father and son)—grasped the possibilities of the situation, and realised the need for well-equipped quays laid out in

such a way that cargo could be brought from or sent to inland destinations with the maximum of speed. Fortunately Francis Giles was also entrusted at the same time with the designs for the London and Southampton Railway, and he was thus able at a very early date to co-ordinate the interests of railway and port. The outer dock was opened in 1842, the inner dock (which remains the only non-tidal dock) a little later. Unfortunately the docks were not an immediate financial success, and in order to raise capital for the building of the Empress Dock (opened in 1890) the company who owned the docks had to seek the aid of the London and South-

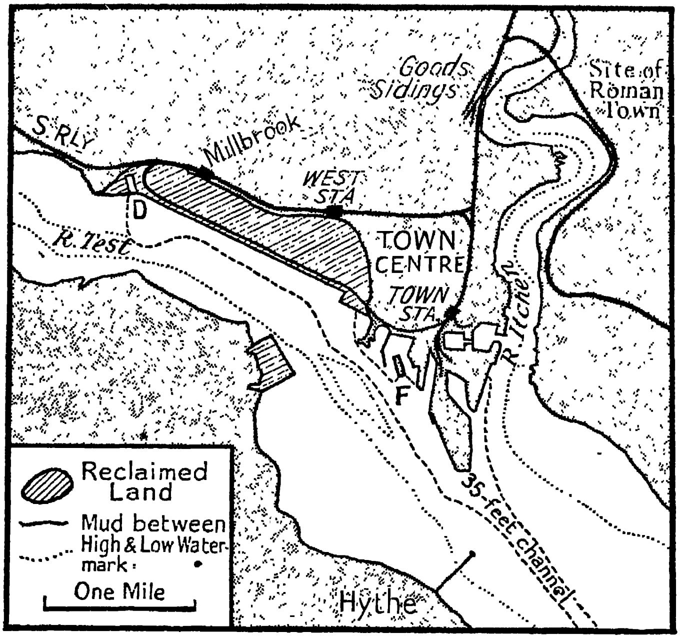


Fig. 276.—The port of Southampton.

Showing the extension now in progress of construction with the largest graving dock (D) in the world—capable of taking larger vessels than any yet built (opened 1933). F = Floating Dock. *Note:* the West Station is now called Central.

Western Railway Company. The Company purchased the docks in 1892, and, under the direction of Sir Charles Scotter, various development and improvement schemes were put in hand. In the next few years the river quays facing the Itchen and Test were erected. Later came the Ocean Dock, which was opened in 1912, and a further enormous extension to the west of the existing port is now in course of completion. In this respect it should be noticed that Southampton shares one of the advantages of London. It is situated in the Hampshire Tertiary Basin, and the soft material of the Tertiary rocks offers no particular difficulty in excavation.

The old outer dock is still in use, mainly by cross-channel steamers belonging to the Southern Railway, and operating the services to the Channel Islands and such ports of France as Le Havre and St. Malo. The southern side of the inner dock is devoted particularly to the import of fruit, and Southampton has specialised in the rapid handling of large quantities of fruit and has attracted the trade in this commodity from South Africa. The Itchen and Test quays are used particularly by the Union Castle Line from South Africa, the Empress Dock by the steamers of the Royal Mail Steam Packet Co., whilst the Ocean Dock is that which accommodates the giant trans-Atlantic liners of the Cunard-White Star Line, and the

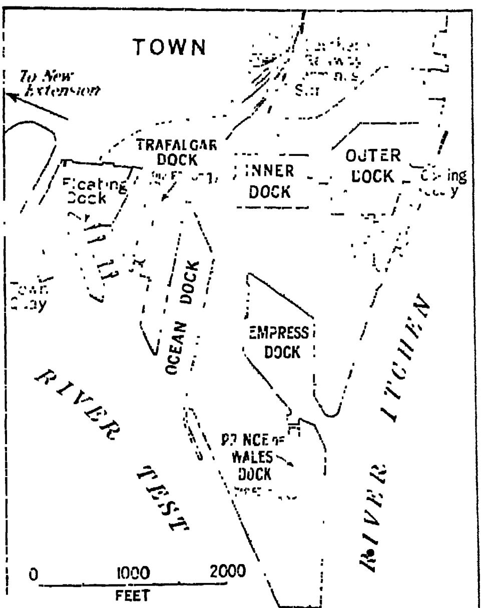


FIG. 277.—Details of the docks of Southampton.

Owing to the small tidal range and sheltered position there is only one small non-tidal dock (the Inner Dock).

United States Line. It can accommodate four of the largest liners afloat at one time, but they now use particularly the quays of the recently reclaimed area. In order to dry-dock these large vessels, a floating dock was built and brought to the port in 1924. It was then the largest floating dock in the world, capable of lifting a vessel of 60,000 tons displacement. It has now been largely replaced by the new graving dock at the western end of the new quays and which can accommodate the *Queen Mary* (70,000 tons) and *Normandie* (79,000 tons). In addition there are six older masonry graving docks or dry docks varying in length from 281 to 912 feet. The largest was widened in 1912 to accommodate

the *Olympic.* There are thus several special features of Southampton as a port. In the first place it is essentially a railway port: most of the passengers arrive and depart by train, and the bulk of the cargo is brought and despatched in the same way. Thus much attention is paid to railway equipment, and the whole port is under the unified control of the Southern Railway. It has been specially adapted to cargo that requires rapid handling such as foreign fruit. In addition it has been well equipped for the handling of frozen and chilled meat. To some extent it is an outport of London; but it also serves to an increasing degree the Midlands and even the north. It is an importing port rather than an exporting one. However, the great feature of Southampton is the development of the passenger traffic, and it is the principal passenger port of the whole of the British Isles—more than one-third of the passengers arriving in and departing from this country do so at Southampton. In this connection it is interesting to note the situation of Southampton relative to the position of Britain described in Chapter I. It will be seen that steamship services from the northern coasts of Europe, for example, Germany and Holland, proceeding to the Americas or elsewhere are not taken out of their way to any appreciable degree in order to call at Southampton. Hence it is the regular calling place of the now famous German liners of the Hamburg-Amerika and Norddeutscher Lloyd.[1] There is every reason to believe that Southampton will maintain its position in the future.

HARWICH, DOVER, FOLKESTONE, and NEWHAVEN

The last three of these are so-called "packet stations" in connection with the Southern Railway, the first with the London and North Eastern Railway. They all have a trade somewhat similar in character and functions broadly comparable in each case. It is from these ports that the passenger-ferry services to the Continent leave Britain. They all have an import trade made up of perishable articles such as butter, eggs, fresh meat, poultry, fish, and fruit, as well as manufactured goods of relatively high value in proportion to their bulk—*e.g.* fine silks, which form a considerable proportion of the imports of Folkestone, and wearing apparel of Parisian origin. On the other hand, they have a very small, often negligible, export trade.

BRISTOL

Bristol is an excellent example of a port which had initial geographical advantages of which it made full use, but whose advantages were not of the character that could be so readily adapted

[1] Until 1933 some dropped anchor in Cowes roads, without proceeding up Southampton Water. This accounts for the huge tonnage of shipping credited to the "port" of Cowes in the years 1930–32.

to supply modern requirements as was the case, for example, with London and Liverpool. Thus Bristol, though remaining a port of no mean significance, has failed to remain in the first rank. There is no evidence of a Roman settlement at Bristol, but the low sandstone hill naturally protected by the marshes of the river Frome on the north and the marshes of the river Avon on the south, the two rivers joining farther to the south-west, supplied an excellent defensible position in the troublous times of Saxon England. Below Bristol the River Avon passes through its famous limestone gorge and empties into the lower part of the estuary of the Severn. The shallow and tortuous course of the upper part of the estuary of the Severn gave Bristol an advantage in competing as an outlet not only for the region to the east of it, but also for the Severn valley.[1] The route eastwards from Bristol was well known because of the Roman spa at Bath which was popular at an early date. Connections with Ireland date from an early period and almost equally fundamental relations with France and Spain are indicated by the early development of the wine trade, wine being an important item in the imports of Bristol then as it is to-day. Soap-making, tanning, and wool weaving developed in the thirteenth century, and in 1353 Bristol was made one of the staple towns for the export of wool. The growing importance of the centre was recognised in 1373 when Edward III granted a charter whereby the town and suburbs of Bristol were made into a separate county. In the meantime the settlement had spread to other sandstone hills in the neighbourhood, and the low ground was utilised for the construction of quays. The discovery of America opened a new field for Bristol; but at first there was severe competition between the port and London. The Merchant Adventurers Society of Bristol received its charter in 1552, but London shot ahead and monopolised much of the new trade. However, the foundation of colonies in Virginia in 1606, and Newfoundland in 1610, saw many men from the west country taking part. The famous Hakluyt himself was Dean of the cathedral from 1586 onwards. So in the early part of the seventeenth century came the development of the American trade. Though a decree of 1631 had enacted that tobacco should only be imported into London, there was so much smuggling into Bristol that its importation was legalised in 1649. Then came the development of the great Trade Triangle from Bristol just as from Liverpool; Bristol vessels going to West Africa, taking a cargo of slaves to the West Indies and returning to Bristol. As early as 1612 there were evidently sugar houses in Bristol because there was a protest demanding the removal of one such owing to the danger of fire. The first mention of the establishment of the

[1] Despite the construction of the Berkeley Canal, allowing the passage of vessels of 11 feet draught, Gloucester fell behind in the competitive race.

chocolate industry is in the granting of a patent in 1731 to Walter Churchman of Bristol, whilst in 1753, Joseph Fry was admitted as a freeman of Bristol after five years' residence. But the tortuous course of the Avon practically prohibited the ascent of vessels exceeding 150 tons, and the Merchant Adventurers were compelled in the early part of the eighteenth century to spend considerable sums on additional moorings and the removal of rocks. There was much discussion about the construction of new docks, but nothing definite was done. Bristol largely lost the sugar trade and has never quite recovered. By the time the docks were constructed in the

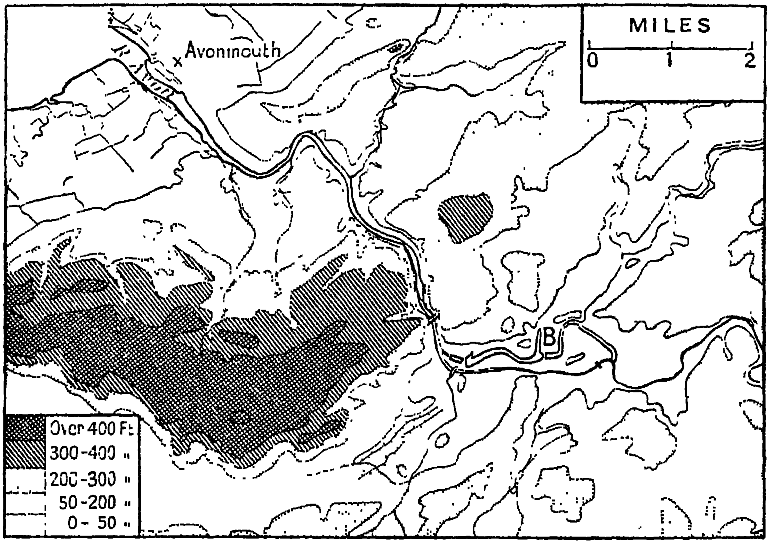


FIG. 278.—The physical setting of the city and port of Bristol (B).

Notice the ridge of high [illegible] the River Avon cuts in the famous Avon gorge *between* Bristol and [illegible] effectually prevented Bristol from becoming a modern deep water port, hence the growth of the outport Avonmouth.

early part of the nineteenth century, it was too late and prohibitive dues annulled the advantages of the new docks. With the coming of the railway era Bristol was unfortunate in its close relationship with the network of 7-foot gauge lines of the old Great Western Railway. These held back the trade of the city especially in connection with the trade of the Midlands; the change of gauge rendered necessary the handling of goods at Gloucester, putting up transport costs and resulting in the diversion of the traffic to Liverpool. It might be thought that the situation of Bristol so close to the Bristol coalfield would have been a tremendous advantage; but there was never any measure of agreement between the coal-owners and workers and the city authorities in Bristol; and indeed,

in 1727, a bill was passed which admitted the setting up of toll gates and taxation on every ton of coal entering Bristol for consumption. But Bristol occupies an essentially valuable position in the west of England, and the obvious though bold move was the construction of modern deep-water docks at the mouth of the Avon. This has been done both to the north of the Avon at Avonmouth and to the south at Portishead.[1] One disadvantage of this site is the enormous rise and fall of the tide, so that vessels have to wait for high tide before they can leave the docks. But facilities have been provided particularly for petroleum storage, the cold storage of butter and meat, the handling of grain,[2] and a special feature of Avonmouth is the docking there of the West Indian banana vessels. Thus the import trade of Bristol has again shown a marked tendency to increase; but the exports are small. The manufactures of the city remain those connected with its old West Indian trade—tobacco, chocolate, and soap in particular.

GLASGOW

The port of Glasgow is situated on the river Clyde 22 miles from the sea. It is in reality the result of efforts made by the citizens of Glasgow to overcome geographical disadvantages. Less than 200 years ago the River Clyde below Glasgow was a spreading and shallow stream full of shoals and sandbanks, fordable at many points as far down the river as 12 miles from Glasgow Bridge. Only about a hundred years ago the river was only navigable by small craft drawing not more than six or seven feet of water. As early as 1668 the town council decided to construct their own port by buying a piece of land 13 acres in extent at a point 18 miles down the river on its left bank. The construction of the town and harbour at New Port was undertaken, the name being changed subsequently to Port Glasgow. Here in 1812, was built the first dry dock in Scotland. But Port Glasgow was too far away, and towards the latter part of the eighteenth century efforts were made to confine the water to the centre of the channel and so to increase the effect of scouring. In 1824 the first steam dredger was brought into operation, and since that date there has been a systematic improvement of the river carried on almost continuously by dredging—as well as the cutting away of the Elderslie rock which presented a serious obstacle for many years. Thus there is now a channel of about 26 feet in depth at low water which, added to a tidal rise of 11 to 12 feet, makes the port accessible for steamers of the largest trading class. Docks have been constructed and the port is now well equipped. The expenditure on the improvement

[1] But Portishead is now almost disused except for coal for the power station.
[2] There are now huge flour-mills as well as storage elevators.

of the River Clyde below Glasgow was warranted by the development of the hinterland. The occurrence of coal and iron close together in the immediate vicinity of Glasgow converted it into the centre of a great manufacturing region.[1] Then there is, further, the fact that Glasgow shares with Liverpool the advantage of facing the New World. It is true that the North American and West Indian trade began as a smuggling trade before the union of the English and Scottish Parliaments, but after the Act of Union so flourished that Glasgow led all its English rivals in the tobacco trade. But Glasgow, contrary to most of the ports of Britain, has developed an exporting trade more than an importing trade. The imports, especially foodstuffs, which are required by Scotland, enter the country particularly by the eastern ports of Leith and Grangemouth, the latter having supplanted Borrowstounness, or Bo'ness, to a considerable degree. Of the future it is difficult to speak, and it has long been realised that Glasgow would benefit enormously by the construction of a ship canal across the narrow waist of Scotland where vessels could coal cheaply en route, and it is quite conceivable that this line would be followed by great trans-Atlantic steamers from the northern coasts of the Continent of Europe on their way to North America.

LEITH and GRANTON

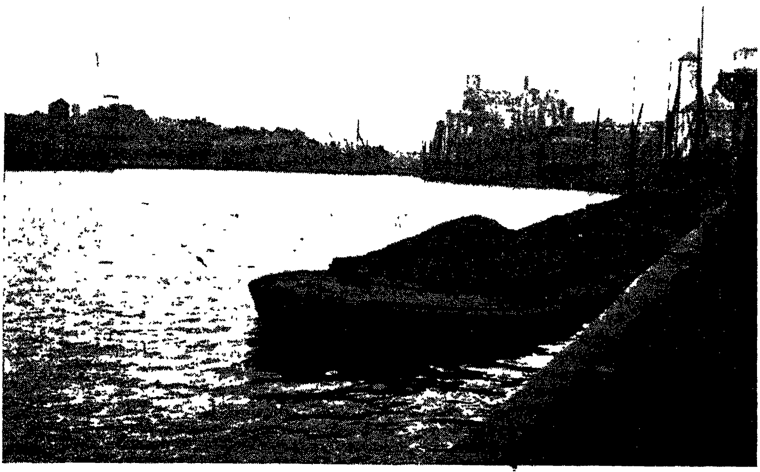
Edinburgh has the advantage of two seaports within its extended boundaries—Leith and Granton. Leith has an import trade similar in many respects to that of Hull, and thus serving as an inlet for butter, sugar, cheese, eggs, and other continental produce required not only for the Edinburgh district but for the more populous district of the Lanarkshire coalfield further west. Granton has not the same facilities for distribution, and specialises rather for ships laden wholly with one bulky commodity. Similarly Grangemouth and Bo'ness specialise particularly in the importation of timber and pitprops required for the collieries.

THE HINTERLANDS OF THE PORTS OF BRITAIN

It has not been possible to delimit with accuracy as has been attempted in the case of Ireland the hinterlands of the ports of Britain. Several points may be emphasised. The first is the great extent to which the hinterlands overlap. Thus London serves an ever-increasing area, including not only the greater part of the Midlands of England, but much of the industrial north. Obviously Liverpool embraces within its hinterland the whole of the Lancashire and the Yorkshire industrial regions as well as the industrial regions

[1] Cf. p. 406.

of the Midlands of England. Hull, whose hinterland was in general co-extensive with the Ouse-Trent Basin, now for some purposes extends its tentacles further, *e.g.* to east Lancashire. But a factor which it is essential to remember is the specialisation of the modern port for the handling of certain classes of goods. Just to take one small example. Avonmouth, possibly one might say a small outport of Bristol, has been specially equipped to handle the bananas which are imported in huge quantities into this country. It is true that in this traffic it has rivals in Garston and London, but notwithstanding that bananas are delivered by rail to all parts of Britain from Avonmouth. In this sense, therefore, the whole of



[*Photo: L. D. Stamp.*

FIG. 279.—The Port of Ipswich.

Typical of the smaller ports, handling particularly "coarse" traffic of coastwise origin. Notice the coal barges and the numerous sailing barges in the background.

Britain may be regarded as lying in the hinterland of Avonmouth. It is only, therefore, in the broadest possible sense that one can attempt any sort of delimitation of British hinterlands.

It will be seen that in this chapter nothing has been said of quite a large number of small but interesting ports of the British Isles. There is in particular one great group of ports—the coal-exporting ports which have, however, been mentioned under the coal trade and the industrial regions within which they occur. Then quite a considerable number of ports are significant to-day for coasting trade. One may take as an example the large quantity of coal which is water-borne to a port like Ipswich; or one thinks of the small ports on the coast of Cornwall that handle the china clay and from

which it is sent to the Potteries or exported to America. Then there are the fishing ports which have been specially mentioned.

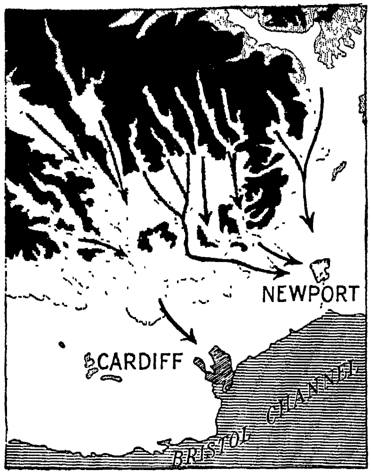


FIG. 280.—Sketch map showing the position of Cardiff and Newport relative to the coal-mining valleys of the South Wales coalfield.

Land over 500 feet dotted over 1,000 feet black.

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CHAPTER XXXI

THE COMMERCE AND PORTS OF IRELAND

By Dora K. Smee, M.A., Ph.D., Lecturer in Geography in the University of London (Bedford College)

In 1935 the Irish Free State [1] had almost twice the population of Northern Ireland, yet the value of trade per head was markedly less. In Northern Ireland [2] (Fig. 283) £36·5 per head represented imports and £35 per head exports. In the Free State [3] these figures were

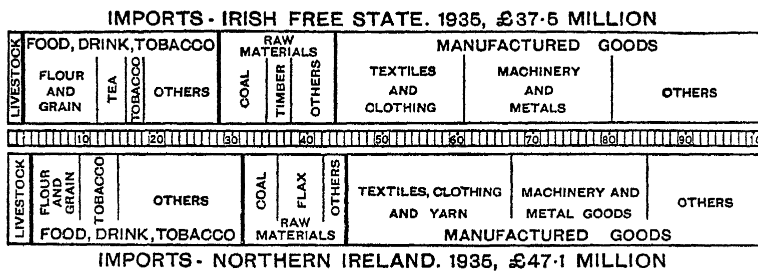

Fig. 281.—The Import Trade of the Irish Free State and Northern Ireland shown comparatively (for the year 1935).

Fig. 282.—The Export Trade of the Irish Free State and Northern Ireland shown comparatively (for the year 1935).

respectively £12·5 and £6·6 per head. Northern Ireland has both a greater import and export trade than the Free State but the difference is most marked in the case of exports. This is due chiefly to the higher value of the commodities exported from Northern

[1] Note.—In this chapter, in order to avoid extensive re-setting of type, the name Irish Free State has been allowed to remain.

[2] Ministry of Commerce. Summary of the Trade of Northern Ireland for the years 1933–35.

[3] Irish Free State. Statistical Abstract, 1936.

Ireland, three-fifths consisting of manufactured products, textile goods and ships (Fig. 282). On the other hand nine-tenths of the exports from the Free State are agricultural products which comprise live animals, dairy, pig, and poultry produce, beer and whiskey, all except the latter being low-priced commodities. This price factor is also partly responsible for the lack of balance between the import and export values of the Free State trade. Neither of the countries exports much raw material but some wool and hides and skins leave the Free State. Since 1927, the trade of Northern Ireland has increased,[1] but during the same period the trade of the Free State has decreased owing to the policy of the Free State government which aims at making that country self-sufficing.

It must not be forgotten that agriculture is the chief industry of Northern Ireland, but agricultural produce and livestock are not

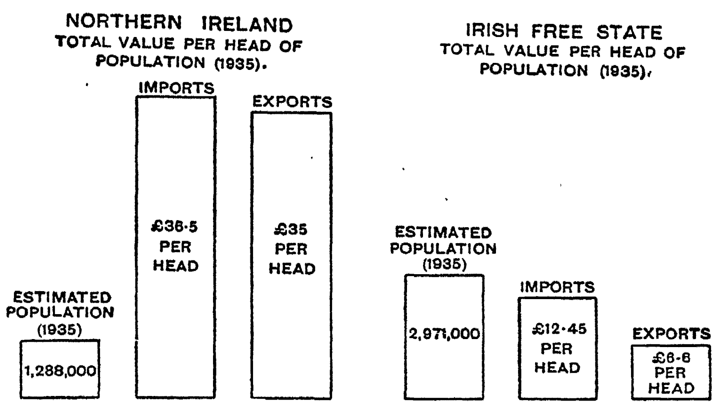

FIG. 283.

exported to the same degree owing to the consumption in the manufacturing areas. The industrial development of Northern Ireland is closely associated with its position relative to the coal, iron, and steel producing areas of western Britain. On the other hand, the large proportion of agricultural produce exported from the Free State indicates the prevalence of the pastoral industries in that country and emphasises the absence of industrial development, except to a small degree in Cork and Dublin. In contrast it will be noticed (see Fig. 282) that the import trade of both countries is almost identical in character, comprising food, drink and tobacco, foodstuffs for livestock, coal, textiles and manufactured goods of all descriptions. Both areas import coal in proportion to their respective populations and Northern Ireland imports flax for manufacture and subsequent re-export.

The vital factor in the external commerce of both countries is

[1] Actual value figures show a decline owing to wholesale price fluctuations.

the close connection with Great Britain. It is impossible to over-stress the importance of these two areas to Britain as markets for her coal and manufactured goods, while no less important is the function of that country as a market for the ships and linen from Northern Ireland and the agricultural produce from the whole of Ireland. Of the two areas the Free State is the more vitally dependent on the markets of Great Britain owing to the perishable nature of her products, which therefore require a market close at hand. Prosperity in Great Britain is especially essential to the well-being of the Free State.

Some of the imports from Great Britain are of foreign origin and are merely re-exports from that country. Similarly, some of the Irish products are destined for places abroad, re-shipment taking place from British ports. Since the inception of the Free State in 1923 State policy has aimed at reducing these indirect shipments, thereby decreasing costs of transport. This reduction in costs can only be achieved when goods such as grain, artificial fertilisers and oil are imported in bulk. Larger boats are being increasingly used, and traffic is deserting certain smaller Irish ports where it is insufficient to warrant expensive schemes for deepening channels and berths, and installing modern equipment for handling occasional bulk cargoes. The external commerce is becoming more and more centred in one or two deep, well-equipped ports, but so long as water transport remains cheaper than rail the smaller ports will continue to function as ports of entry for "coarse" traffic in coal, grain, fertilisers, sand, cement, bricks, potatoes, and peat. The export trade of these smaller ports is non-existent or very small.

As the port of Dublin dominates the Free State, so the port of Belfast dominates Northern Ireland, but both ports function for areas beyond the political boundary. The inter-state traffic is, however, declining as a result of costly delays and thus to a certain extent non-geographical factors are limiting the hinterlands of both these ports. Belfast and Dublin are alike in their functions as capital cities, industrial centres, and foci of road, railway, and, particularly in the case of Dublin, of water routes. Their dominance is due to their geographical position on the east coast, and their continued and increasing importance is witness to the close commercial relations between Ireland and Great Britain.

Northern Ireland

The port of *Belfast* [1] on Belfast Lough (Fig. 284) dominates Northern Ireland. The proximity of the Scottish coast favours

[1] Reports of Belfast Harbour Commissioners. *Port of Belfast.* Handbook of Belfast Harbour Commissioners.

trade relations with the Lowlands and a short sea-route to Stranraer has been developed. The port is, however, not naturally so well

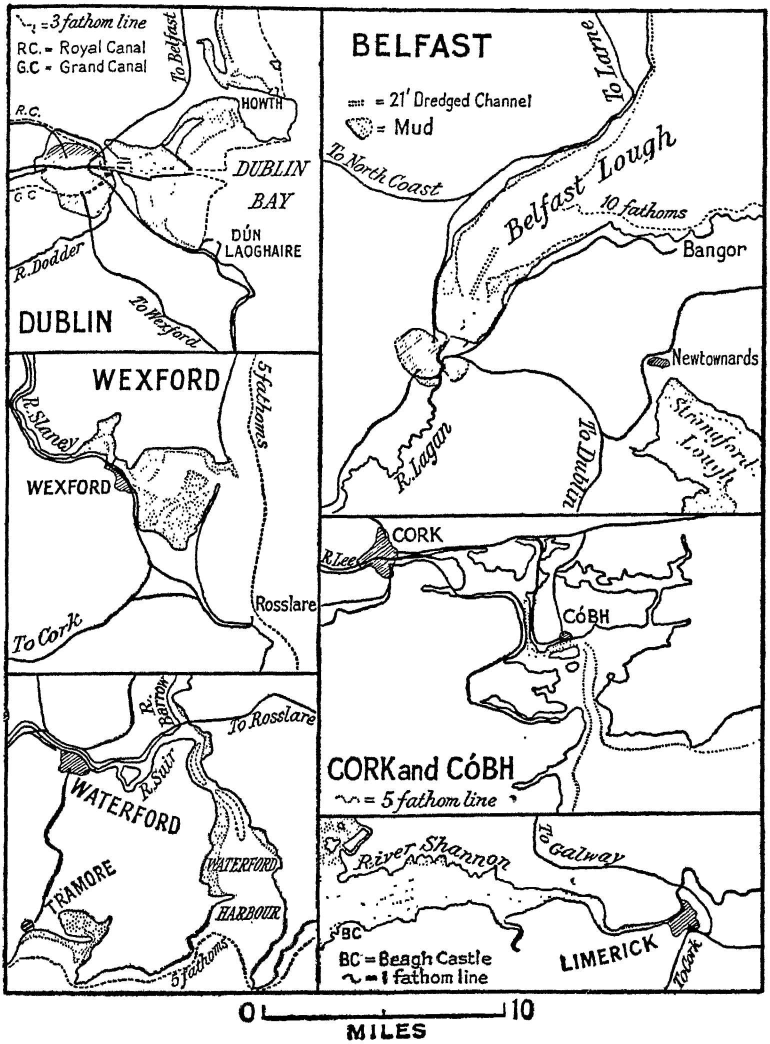

FIG. 284.—Sites of certain Irish Ports. (*See also* Fig. 288.)

placed for trade with the Midlands and the Metropolitan area.[1] The easterly position of the Lough made it worth while to dredge and maintain a navigable channel for the largest liners afloat;

[1] But direct trade is fostered by the excellent services of steamers to and from Heysham and Liverpool.

thus the natural hinterland of Belfast—the Lagan valley—soon grew to include the other lowland corridors and the valleys of the hill and mountain country encircling the Lough Neagh basin (Fig. 122). In this area there are over a million people, and the linen industry, engineering, rope-making, and distilling flourish (see Chapter XXIX). Except for the linen manufacture in the valleys surrounding Lough Neagh, industry is confined to the Belfast district. It is the variety of industry in the immediate hinterland that ensures comparative stability in portal trade.

Topography controls the direction of railways feeding the port.

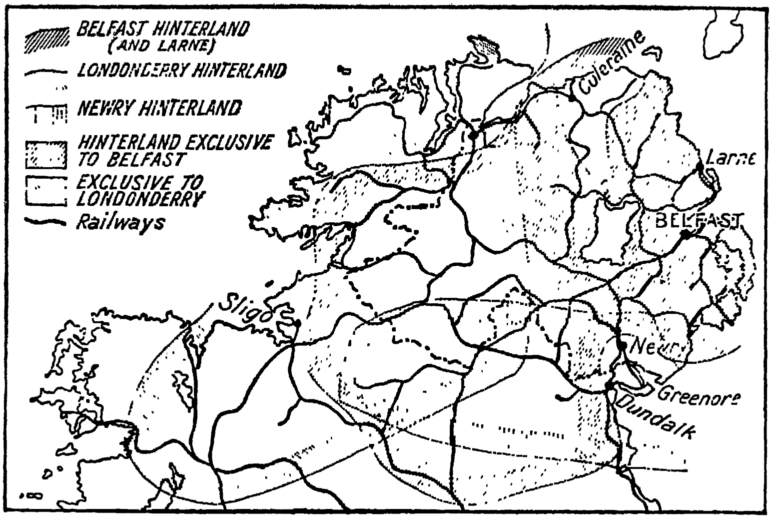

FIG. 285.—The hinterlands of the ports of Northern Ireland.

This map refers to dutiable goods only. The hinterlands for non-dutiable goods, principally those of low specific value and of great weight and bulk, would be smaller than the areas here shown. (From Handbook of the Ulster Question.)

Formerly canal transport was possible from Belfast *via* the lowland corridors to distant parts of the Free State. These have outlived their usefulness, with one exception. The Lagan Canal [1] still collects and distributes bulky and heavy goods of low specific value. The development of railway communication has extended the hinterland

[1] *Cargo carried from Belfast*, 1931.

Coal	64,000 tons
Maize and general cargo	24,000 tons

Traffic to Belfast.

Fresh water sand	25,000 tons
Peat, fireclay, and timber	4,000 tons

The Canal Company pays a small annual dividend.

of the port beyond what might be termed the natural service area (Fig. 285). It is largely by reason of the good railway—and latterly of road—facilities that the vested interests in Belfast to-day see that the competitive power of other ports is effectively strangled. It is only in "coarse" goods that distance from the port of landing is an important factor. The distance these commodities can travel varies according to the cost of freight, port dues, goods dues, and loading and unloading charges at individual ports. Belfast[1] is in this respect especially favoured for distributing coal. By reason of the low charges, based partly on the short sea route, the excellent equipment for handling coal in bulk, and the facility for bargaining, coal is enabled to travel long distances from Belfast before coming into competition with coal distributed from other ports. Perishable goods such as eggs, butter, and livestock very often ignore geographical distances and freight charges, as rapid transport and port facilities are the determining factors. Livestock (fat and store) destined for the Glasgow market often travel from the Free State *via* Belfast. Actually cattle sold in the Dublin cattle market will travel northwards to Belfast, if shipping space is not available the same night at Dublin, or if it is found that the prices in Glasgow are higher than elsewhere.[2]

In 1936 the total net register tonnage clearing from the port was 4,570,159 tons. Approximately one-fifth of this shipping was from foreign ports direct, and the remainder was cross-Channel and coastwise. Three-fifths of the direct shipping was British, whilst Dutch and American vessels were also numerous. Most of the ships carried

[1] Table of Approximate Cost of Transportation of Coal from Garston, Whitehaven, and Ayr, and of Discharging same into Rail Wagons at Certain Ports.

Minutes of Evidence (kindly lent by the Ministry of Transport, I.F.S.) of the Ports and Harbours Tribunal 1927. Freely used in matters pertaining to all Irish Free State (except railway and privately owned) Ports.

From Garston and Whitehaven	350-ton cargoes	700-ton cargoes
Dundalk	7/0½	6/5
Newry	6/7	6/–
Dublin	6/3	5/8
Belfast	4/10	4/4
From Ayr		
Dundalk	7/7½	6/5
Newry	6/7	6/–
Dublin	6/3	5/8
Belfast	4/1	3/10

[2] The position has, of course, been complicated by tariff changes.

mixed cargoes. As a port of call, Belfast is important, being used by trans-Atlantic liners from Glasgow and Liverpool. Fuel, food, and raw material are distributed from the port, and manufactured goods and agricultural produce are collected by it (some redistributed by coastwise steamers). The chief commodities are indicated in Figs. 281–2, which show the external commerce of Northern Ireland.

Londonderry,[1] the second port, is at the head of Lough Foyle (Fig. 288), twenty-five miles from the open sea on a very stormy coast. Seawards from Moville the depth in the navigable channel is not less than 30 feet, but from there towards the port the channel, dredged where necessary, is 18 feet at L.W.O.S.T. (rise of tide 6–8 feet). Above Londonderry the Foyle is navigable to Dunnalong (draught 7–8 feet) and to a point four miles farther up where the canal is entered through Strabane, the river is navigable for barges (draught 5 feet). The natural hinterland of Londonderry is the basin of the Foyle, beyond which on the east and south Belfast actively competes. The hinterland of the port has been extended westwards by the railways [2] (Fig. 285). The mountainous nature of Donegal, the grain of the country south-west to north-east, and its exposure to the full force of the Atlantic are, however, geographical factors that have favoured Londonderry. No other port is likely to develop on this coast,[3] in a latitude too far north of the world routes converging on N.W. Europe. The political boundary between Northern Ireland and the Free State cuts the natural hinterland in two, and the traffic in dutiable goods west and south of the Foyle basin would doubtless have diminished greatly had it not been for the absence of direct rail communication between Donegal County and the Free State.

The net register tonnage using Londonderry is shown in Fig. 286. Trans-Atlantic liners [4] plying between Glasgow and New York and Canadian ports formed 50 per cent. of the volume in 1936; cross-Channel steamers, chiefly to Heysham and Glasgow, formed 42 per cent., and the remaining 8 per cent. represented vessels direct from foreign ports. The imports are similar to those of Belfast, with certain exceptions. There is practically no im-

[1] Reports of Londonderry Port. Harbour Commissioners.

[2] Railway wagons run alongside vessels, but part of this advantage is lost owing to the absence of modern discharging apparatus. The port is unpopular with grain vessels on this account.

[3] After the political boundary had been fixed direct fortnightly sailings were arranged between Liverpool and Dungloe. Boats carried a general cargo (including maize). If other small harbours do likewise, the hinterland of such ports in the absence of further railway facilities would be limited to the narrow coastal plains.

[4] These lie off Moville (I.F.S.), and passengers are shipped by tender.

portation of iron and steel goods or of flax and cotton goods, owing to the limited range of manufacturing industry in the Foyle basin, and the absence of factory production in Donegal (the only part of the hinterland exclusive to Londonderry). The export traffic is characteristic of all Irish ports other than Belfast. Agricultural products dominate but are small in total value, and include an increasing number of cattle, sheep, bacon and hams, and eggs (the Londonderry area specialises in the last three). Small quantities of pigs, oats, meal, hides, grain, offal, hay, potatoes, and grass seed are exported—the same type of traffic as is exported through the port of Belfast from the Lough Neagh basin.

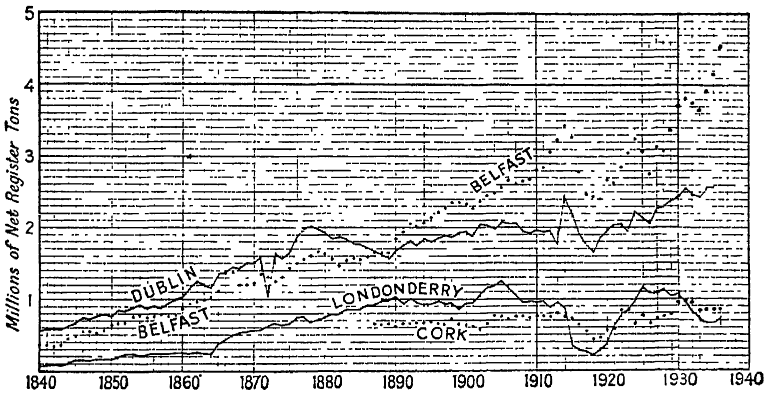

FIG. 286.—Graphs showing the tonnage of vessels entering the chief ports of Ireland.

The manufactured products consist chiefly of cotton and woollen goods, burnt ore, and a steadily decreasing quantity of cured herrings. It is unlikely that much increase in port trade can be looked for in the immediate future.

There remain to be considered three other small ports in Northern Ireland. The most important of these is Larne, at the mouth of the entrance to Larne Lough, twenty miles north-east of Belfast and, therefore, nearer to the Scottish mainland. To this factor the importance of the daily passenger service to Stranraer is due. There is also a regular service to Ayr (thrice weekly) and Liverpool (once weekly). The port (17 feet L.W.O.S.T.) is suitable for vessels engaged in the cross-Channel trade and for small ocean-going steamers.

Larne [1] (Fig. 285) serves a small area limited by topographical features which hinder rail and road communication. Poor soil

[1] Larne Harbour is a private concern and no figures are available. It is a railway port (L.M.S. Railway).

supports a scanty population, and only in Larne itself are there small industrial concerns.[1] The chief imports are coal, bauxite (from S.E. France), pulp, and bricks, whilst the exports are the characteristic Irish agricultural products, with the exception of alumina manufactured from bauxite.

The only harbour of any importance between Larne and Londonderry is that of *Coleraine* [2] on the river Bann, four and a half miles from the open sea. This small port is vital to the basins of the Bann and Bush between the Sperrin Mountains and the Antrim Plateau. In 1930 the net register tonnage entering the harbour was only 48,715 tons, shipping being severely limited by the physical condition of the port. The river water is dissipated over large areas, and the consequent deposition renders the depth of water uncertain and navigation dangerous. The depth at the entrance (9 feet) limits the port to shallow cross-Channel steamers. A weekly service is maintained with Glasgow and Liverpool and goods can be unloaded direct by small cranes into railway wagons alongside. The hinterland (Fig. 285) is thinly populated, and Coleraine numbers only 8,000 people (1926). A good network of roads serves the hinterland where railways are absent. Up-stream the river is canalised (6 feet at summer level) and hundred-ton cargo boats can proceed to Lough Neagh. The traffic consists of coal, agricultural produce, peat, and diatomite clay (found between Toome and Kilrea). About 30,000 tons of potatoes annually form the most valuable part of the export trade. The former cattle trade with Glasgow has practically ceased since unsatisfactory harbour conditions make it impossible to guarantee the arrival and departure of boats. The traffic has been captured by Belfast and to a small extent by Larne.

Flowing into the head of Carlingford Lough is the canalised Newry river connected with the Lough Neagh and Lagan basins. Below the estuary is a bar, and five and a half miles above it on the river stands the port of *Newry* [3] (12 feet H.W.O.S.T.) just within Northern Ireland. Newry has lost the greater part of its hinterland (Fig. 285) that lay westwards across the present frontier. The competition of Belfast effectively limits its hinterland northwards. The imports include coal, grain, timber, and general cargo, and the exports are small quantities of linen, timber, granite, oats, and potatoes. The port (population 1926, 12,226) has corn and flour-mills, iron and brass foundries, and linen, yarn, cotton, salt, and cordage factories.

[1] But the powerful railway interests give Larne, in many respects, a hinterland co-terminous with that of Belfast. It serves, in many ways, as an outport of Belfast.

[2] Report on Improvement of Entrance to Coleraine Harbour. H.M.S.O.

[3] Railway owned, therefore no statistics available.

Irish Free State

The Irish Free State shipping, exclusive of liner and mail traffic from Cóbh (Queenstown), Galway, and Dún Laoghaire (Kingstown), was 5,359,448 net register tons (1935). *Dublin* accounted for 38 per cent. of this. Eighteen ports and a group entitled "Other ports" shared the remainder, so it is at once apparent that Dublin has more shipping than any other port in the Free State. In the opinion of Sir John Purser Griffith this port is the only one which would be a loss to the country as a whole. As regards its navigation, harbour facilities, and internal communications, it is the equal of Belfast. But although it has growing and established industries based on agriculture, it has not the same concentration of population in its immediate hinterland. Without further development in industry or increase in the rural population, Dublin must remain second to Belfast. It enjoys a better position for trade with the Midlands and the south of England, the advantage of the sea route to Holyhead with express connections therefrom, and a central position as regards the transport system of all Ireland.

Owing to the smallness of the Liffey catchment basin, the low rainfall of the plain and the lack of gradient, the channel in the estuary was formerly shallow and the deposition of sand constant. Improvements have continually been made to provide deep-water berthage (35 feet) for the large ocean freighters now engaged in the "parcel trade." The channel through the bar (20 feet L.W.O.S.T.) enables the port to be open at all states of the tide [1] to cross-Channel vessels. Constant and extensive dredging will always be necessary. Above the Loop Line Railway Bridge (Fig. 284) steam lighters go to the breweries of Messrs. Guinness at St. James's. Up-to-date electrical equipment and plentiful and efficient labour are available, and the former low grain [2] discharge rates for Dublin have improved, so that Dublin now compares favourably with competitive ports. It is conveniently placed for the direct importation of grain which comes in bulk [3] from the United States and Argentina. It is hoped that maize and wheat, formerly shipped from Liverpool and Manchester, will be shipped direct, and that the Dublin coastwise distribution trade will regain its former importance. There are modern facilities for the bunkering of oil, but not of coal. Coal is brought by horse carts, and only occasionally shipped by cranes. Only certain berths on the north side of the river have direct rail communication, but on the south side there is none, which limits development there. There is no passenger railway service in connection with the quays, and this has diverted traffic to Dún Laog-

[1] Vessels of deeper draught have to wait for the tide.

[2] The merchants sold grain ex ship to avoid warehouse costs, and labour would not permit the discharge by suction pipe to the silo.

[3] Australian grain is bagged.

haire (Kingstown). In spite of this about 100,000 passengers travel annually between Dublin and Liverpool by the regular daily service, which also takes livestock and goods. There are also regular (but not daily) passenger sailings to Glasgow, Silloth, the Isle of Man, and London, and once weekly to Waterford and Cork. The Royal Canal, almost derelict (boats draw $2\frac{1}{2}$ feet), enters at North Wall Quay, and the annual traffic carried is about 20,000 tons. On the south side the Grand Canal (boats draw 4 feet) enters at Ringsend, where the canalised Dodder joins the Liffey. The canal boats, being self-propelled, can cross the Liffey and enter the deep water Alexandra Basin for grain. The Grand Canal has an annual total traffic of 200,000 tons, much of which passes through the port. Agricultural products are the most important, including grain, malt, flour, salt, potatoes, and artificial manure. General merchandise ranks next in importance, followed by coke, and building materials.

The hinterland of Dublin (1936, population 467,691) includes the whole of the Free State (1936, population 2,965,854). The ports of Dublin, Waterford, Cork, and Limerick account for two-fifths of the urban population, while smaller coastal ports and small market centres [1] account for the remainder. The rural population (62 per cent. of total) is densest in the south-west and in the northern districts remote from Dublin. The counties round Dublin show the smallest densities. The effect of this distribution on port traffic is not generally appreciated, but together with the predominance of agriculture it determines in a large measure the character of the imports and the nature and the volume of the exports from Dublin. The needs of such a population are definable. A demand for fertilisers, maize, meal, and cattle cake is constant. There is everywhere a demand for English coal, and ports and railways are still dependent on it. Being favourably situated in regard to cross-Channel coal ports, and having unique facilities for distribution, Dublin is the largest coal importing port.[2] Clothing and manufactured articles, numerous in type but small in individual quantities, are required by the small population with a purchasing power commensurate with agriculture that has been neither intensive nor very scientifically organised. There is a demand within the State for the cheaper grades of bacon, butter, milk, ale, beer, and hop bitters from other countries. There is also a large import of wheat, flour, barley, malt, tobacco, tropical products (tea, sugar, and fruits), motor spirit, petroleum, and cement. In 1927, large quantities of steel passed through the port for the Shannon Power Scheme. For the distribution of goods Dublin has no equal in the Free State, and the commercial and industrial activity in Dublin

[1] Of 43 towns containing more than 5,000 people only 23 are inland and include between them only 160,000 people.

[2] In 1935, Dublin imported 1,044,749 tons of coal.

attracts traffic through the port. As a collecting centre Dublin is pre-eminent. Goods destined for Great Britain must travel eastwards. The perishable nature of the livestock and dairy produce, the value of which largely depends on quick and efficient transport, directs traffic towards the port. Dublin is only 61 miles from Holyhead and 121 miles from Birkenhead.[1]

In 1935, the net register tonnage entering Dublin [2] was 2,582,099 (Fig. 286), the largest on record; and the increase is largely due to the overseas "Parcel trade," and foreign liner tourist cruises. Thirty-two per cent. of the shipping is direct [3] from foreign ports, and the remaining sixty-eight per cent.[4] is from cross-Channel ports. Any dislocation of the coal trade in Dublin benefits Belfast, Cork, and other Irish ports, and this has emphasised the large area served by the Dublin coal merchants. Coal formed almost half the tonnage of goods imported into Dublin in 1935.

The feature that distinguishes Dublin from other ports is the large export of livestock—cattle,[5] sheep, and pigs, forming half the export traffic. The internal trade in livestock concentrates on the port of Dublin owing to its relation to the English ports and markets, to the fattening pastures of Meath and Kildare, to the Golden Vale country, and to the store-raising areas of the central plain and the south-western peninsula (see p. 245). Seventy per cent. of the livestock exported from the Free State passes through Dublin. In 1935 Dublin accounted for two-thirds of the sheep and a third of the pigs exported from the Free State. Dublin exports a bigger percentage of fat stock than any other port, and these are slaughtered in the abattoirs at Holyhead and Birkenhead. The carcases are then forwarded to London and other industrial areas. The time taken in crossing is very important to fat cattle, which soon lose weight. Store cattle are landed at Birkenhead, Liverpool, Heysham, Manchester, Preston, and Silloth, and are distributed to parts of Wales, the Midlands, and East Anglia. The export of pigs and sheep from Dublin and the Free State has steadily declined during the last three decades. The sale of livestock in Great Britain is largely dependent on prosperity in that country, and in future may have to face the competition of Canadian

[1] Compare Cork, 254 miles from Liverpool, Waterford 208 miles from Liverpool, Dublin to Glasgow 196 miles, Limerick to Glasgow 420 miles.

[2] Reports of Dublin Port and Docks Board.

[3] Until new markets are found for Irish produce and existing foreign markets further developed, no important reduction in the proportion of cross-Channel traffic is probable.

[4] 22 per cent. of the cross-Channel shipping consists of colliers, which return to Great Britain in ballast.

[5]

	1935
Fat and store cattle	348,609
,, ,, sheep	199,287
,, ,, pigs	43,182

export of biscuits, less important than formerly.[1] A curious item in the export trade is that of high-grade coke shipped direct to Norway from the Pigeon House Quay power station. The direct export traffic to foreign countries is small, and amounted in 1935 to 47,376 tons, only one-ninth of the total export tonnage from Dublin. Coastwise traffic to and from the port is small in total amount. It had disappeared by the end of the War, is slowly improving, but its future is limited by the development of road transport. Half the existing coastwise import traffic is in malt, and the remainder consists of cement, maize, cotton seed, meal, sands, and gravels. Half the coastwise export traffic consists of artificial manures, porter, and biscuits, all manufactured in Dublin. The remaining half comprises motor spirit, paraffin, petroleum, and flour from firms with storage tanks and warehouses on the reclaimed ground at the deep water Alexandra basin.

Other ports on the east coast of the Free State are either passenger and mail ports, like Dún Laoghaire (Kingstown) and Rosslare, or secondary ports like Drogheda, Dundalk, and Wexford, which compete with Dublin but have limited facilities for navigation and trade. In the south-east are the smaller ports of Wicklow and Arklow which compete with Dublin for certain "coarse" traffic within a very restricted radius.

The harbour of *Kingstown* (20 feet L.W.O.S.T.) is formed by two granite piers extending towards Howth, from the south shore of Dublin Bay. Built in 1817, for a refuge during south-easterly gales, Kingstown developed into the passenger and mail port for Dublin and Ireland. The depth of water at Holyhead controls the draught of the cross-Channel steamers. Kingstown has a more specialised traffic than any other port in Ireland, and is dependent on the short distance to the coast of Britain where the port used is Holyhead (L.M.S. Railway). Its rival is Rosslare (service from Fishguard, G.W. Railway). Many steamers call at Kingstown for English bunker coal, but this traffic has steadily declined during the last three decades.

Dundalk Bay is enclosed on the north by the igneous mass that partly encircles Carlingford Lough, and on the south by Clogher Head, where the granitic core and Silurian shales and sandstones rise from the sea, and where rapidly shallowing water penetrates for some distance inland into the Carboniferous and Triassic beds exposed by denudation. Above the entry of the Castletown river into the bay is the port of *Dundalk* (Fig. 288). River and tide conditions produce, as they did at Dublin, a bar of shingle and sand which effectively limits here the draught of vessels using the port ($4\frac{1}{2}$ feet L.W.O.S.T., $15\frac{1}{2}$ feet H.W.O.S.T.).

[1] Result of fiscal system—tax on sugar into Great Britain—sweet biscuits now made in the Liverpool factory.

In addition, the river is narrow (200–300 feet), limiting the cross-Channel and coasting trade to six hours daily. No increase in traffic [1] can be hoped for under existing port conditions, especially as ships tend to increase in size and goods must be handled in bulk by mechanical equipment. Costly improvements would not be justifiable as long as first-class and other secondary ports lie within 50 miles to the north and south.

The principal traffic is the importation of coal [2] which is distributed in Dundalk (1936, population 14,686), sent to inland centres by rail and supplied to the Great Northern Railway. Expansion of this traffic is unlikely as Belfast has a shorter sea route for those areas equidistant from both ports, and it is possible that Greenore and Newry might supply the Great Northern Railway with coal. It is possible too that with the increasing use of Shannon electricity the demand for coal may decline in the western part of the hinterland. Small quantities of maize, flour, and foodstuffs arrive in coastwise vessels. The export trade to Liverpool largely consists of livestock (mainly cattle and sheep) and some oats. It has declined by half since the pre-War period, partly owing to the financial difficulties of the shipping company which was forced to suspend the sailings for nine months and to discontinue the unimportant Glasgow–Dundalk service.

The hinterland of the port is shared by many others (Figs. 285 and 287), and includes that part of the Free State with the most continuously dense rural population. Part of the hinterland lies in Northern Ireland. The decline of the port is due in part to the setting up of the frontier, resulting in the diversion of goods from Enniskillen and other Northern Ireland districts, together with the loss of dutiable traffic on the old Cavan–Leitrim Railway.

Just within the Free State on the south shore at the seaward end of Carlingford Lough is the port of *Greenore* (1926, population 1,544), specially constructed by the L.M.S. Railway,[3] and open at all states of the tide to cross-Channel steamers. Cargo steamers sail regularly to Holyhead, and there cranes discharge cargoes direct into wagons. The political boundary has cut the port off from part of its hinterland (Fig. 285) which lies to the westward and north-westward in Northern Ireland. The imports include coal, galvanised sheets, horses, bolts, iron nuts, and oysters, and the exports include cattle, sheep, pigs, poultry, pork, and potatoes, typical Irish products needing rapid transit.

The port of *Drogheda* (Fig. 287) differs in some respects markedly from that of Dundalk, the difference arising directly from the physical setting. The port will admit small overseas vessels at

[1] 1935. 92,282 net register tons. Average 1909–13, 172,743 tons.
[2] 1925. 130,000 tons.
[3] No statistics are available for railway-owned ports.

high-tide and cross-Channel and coasting vessels for a longer period on each tide. In this respect Drogheda ($4\frac{1}{2}$ feet L.W.O.S.T. and 17 feet H.W.O.S.T.) is superior to Dundalk, but entry is difficult during heavy weather. As at Dundalk, most of the quays have insufficient water for the berthing of ships, which consequently lie 28 feet away; and cargo is unloaded by means of gangways. Coal vessels can now lie alongside. The port, unlike Dundalk, has no connection with the railway, as the G.N. Railway crosses the river at right angles 80 feet above the quays. Until 1928 the port had no cranes; since when two three-ton steam travelling cranes have been erected. There is a regular service to Liverpool twice weekly. The net register tonnage of vessels using the port was 64,375 in 1935, considerably less than it has been formerly, and the cargoes handled show an even more marked decrease. In 1928, the imports were 55,000 tons, half of which was coal. The coal import is declining, chiefly owing to the absence of rail connection at the port and the heavy charges in the past connected with the discharging by human labour and road haulage. Coal, imported at Dundalk, is actually sold in the port of Drogheda (1936, population 14,495). The general imports are maize, flour, artificial manure (direct from North African ports), timber, and cement; but small quantities of cotton yarn, sizing flour, starch, and cotton cloth are imported for the weaving, dyeing, finishing, bleaching, and ready-made clothing industry. The industry consumes 3,000 tons of coal annually. The small export trade was 5,000 tons in 1928 and 67,000 head of livestock. The traffic continues to shrink, and was seriously affected by the closing in 1928 of the Drogheda Fresh Meat Factory. A study of the hinterland (Fig. 287) shows that the port serves an area within a radius of twenty miles and beyond that distance other ports actively compete. The fact that Dublin and Dundalk have railways along the quays serves to limit traffic at Drogheda. Costly improvements which might result in increased traffic would be made only at the expense of well-equipped harbours, seeking to repay the enormous sums already spent on their development.

From Dublin southwards, broad bays have been carved between the headlands of more resistant rock. In one of these on a lagoon coast north of Wicklow Head lies the port of *Wicklow* (17 feet H.W.O.S.T.) on both banks of the Leitrim river. A breakwater and pier have been built as protective measures for the shore and river mouth, and these are used occasionally for the discharge of goods. Silting, uninterrupted by dredging during the last decade, now prevents small shallow coastal vessels drawing more than 11 feet from navigating the river, and the result is a decrease in shipping [1] and in the goods [2] passing through the port. This port

[1] In 1928, 10,000 net register tons. [2] Biggest decrease in export traffic.

and Arklow are the only ones on the east coast that do not export livestock or have regular sailings to cross-Channel ports. The sole import is coal, except for an occasional cargo of flour and feeding stuffs, and of slag and kainite for the chemical works north of the town. A crane is used for the direct discharge of coal into wagons. The export traffic consists of burnt ore, oats, and timber. The hinterland (Fig. 287) contains a scanty population engaged in agricultural pursuits, and small urban centres where valleys meet. Wicklow was useful in former times before the first-class ports developed, and when sailing ships needed an asylum between Dublin Bay and Waterford ; now it has outlived its usefulness.

Arklow stands where the river Avoca enters the sea 15 miles to the south of Wicklow Head. Two parallel training walls, built seawards in an effort to control the silting at the river mouth, prove ineffective during prolonged west and south-west winds, when the harbour becomes completely barred until easterly winds prevail and carry the sand outwards. Shippers charge high freights, as the varying depth of the water occasionally means delay and ships are prevented from entering. All navigation is restricted to a few hours each day. Were it not for the heavy expenditure on dredging—partly met by the Department of Fisheries—the harbour would silt up altogether. The port is chiefly used by fishing boats drawing 5–6 feet. Arklow is the largest fishing port in the Free State, with thirty motor and ten sailing boats. A few years ago girls from Scotland and Donegal taught those of Arklow how to cure herrings, and it was hoped that fish curing would become an industry in the town. The market for the fish lies inland. There are fifty to sixty small trading vessels, manned and owned by Arklow men, trading between British and Continental ports, that only go into Arklow for repairs. Arklow (1936, population 4,679) is thus unique among Free State ports. Fishing is the only industry,[1] and there is no other in the hinterland. The imports are coal, millstuffs, slag, and manure, and an occasional cargo of non-dutiable general goods. Since 1921, the tonnage exported has risen to 14,833 tons (chiefly consisting of gravel and sand sent to Liverpool and Wallasey), but the general trade of Arklow has diminished in real importance. Its hinterland can be served economically by Dublin, Wexford, and Waterford, ports with deeper water, quicker discharge rates and railways alongside.

The accompanying sketch map (Fig. 284) shows the position of the Port of *Wexford* as the mouth of the Slaney, a river draining from the highest part of the Leinster chain and flowing parallel with it on its western flank. The Slaney then cuts across the Leinster and subsidiary chains to the east coast. More or less

[1] Earthenware and china works have been recently established on the shore for the Free State market.

parallel, but farther to the west, is the river Barrow, flowing southwards into Waterford harbour and forming a natural western limit to the service area of Wexford. Between Wexford and Gorey lies broken hill country; to the south the Mountain of Forth rises from an undulating lowland bounded eastwards and southwards by a lagoon coast. The valleys and lowlands are fertile areas; in fact, Wexford county is the premier agricultural county in the Free State (see p. 243).

The harbour can only be entered at high tide (12 feet) and by day, as there are no lights. The road connections to the port are excellent, and of late motor transport has supplemented the few railways feeding the port (Fig. 284). The railway runs along the quay and continues eastward to Rosslare harbour. There are 3-ton and 10-ton cranes for the direct discharge of goods from ship to wagon. During the last three decades the net register tonnage using the port has decreased,[1] but the traffic handled on the quays has increased, which shows that vessels evidently leave with more complete cargoes. There is a regular steamship service to Liverpool.

The usual feature, the importation of coal, is not prominent, since sea freights to Rosslare are lower and coal for Wexford often comes through that port. The other imports are foodstuffs, cement, flour, timber, and general cargoes. The main exports are oats, malt (industry in Wexford), potatoes, prop timber, cereals, and agricultural implements. The malt goes to the Dublin breweries. Two recent developments are the import of maize for a grinding mill at the port, and the export of cattle by a new shipping service to Liverpool. Between 1912 and 1928 there was no export of livestock. The herring fishery is small in extent and remains relatively unimportant; the fish are sent inland by rail. The port functions as long as the bar and channel are dredged, and as long as it can compete with the railway-owned port of Rosslare. There is no commercial element in Rosslare, and it remains to be seen whether the Wexford merchants will remove to that port or whether Rosslare will become the port for Wexford.

The port of *Rosslare* belonged to the Fishguard and Rosslare Harbours Co. which controlled the railways between Rosslare and Mallow on the Irish side, and the railways for a short distance on the Fishguard side to a junction of the G.W. Railway. After the amalgamation of the railways in the Free State it was only natural that the new company working the line should definitely favour[2] the use of Rosslare in so far as unconsigned[3] traffic (Fig. 284) was

[1] 1935, 20,822. 1903, 79,728.

[2] Railway Act, 1924, provides that the Great Southern Railway cannot favour one port rather than another by rail facilities or other matters.

[3] Unconsigned traffic is traffic sent by no specified route.

concerned. The port, specially constructed, has a nightly service each way to Fishguard, and fast trains to Cork. As a passenger port on the east coast it rivals Dublin ; as a cargo port it is second. The journey from Cork to London *via* Rosslare [1] is $2\frac{3}{4}$ hours shorter than *via* Kingstown and Holyhead—an important consideration for business men and American mails.

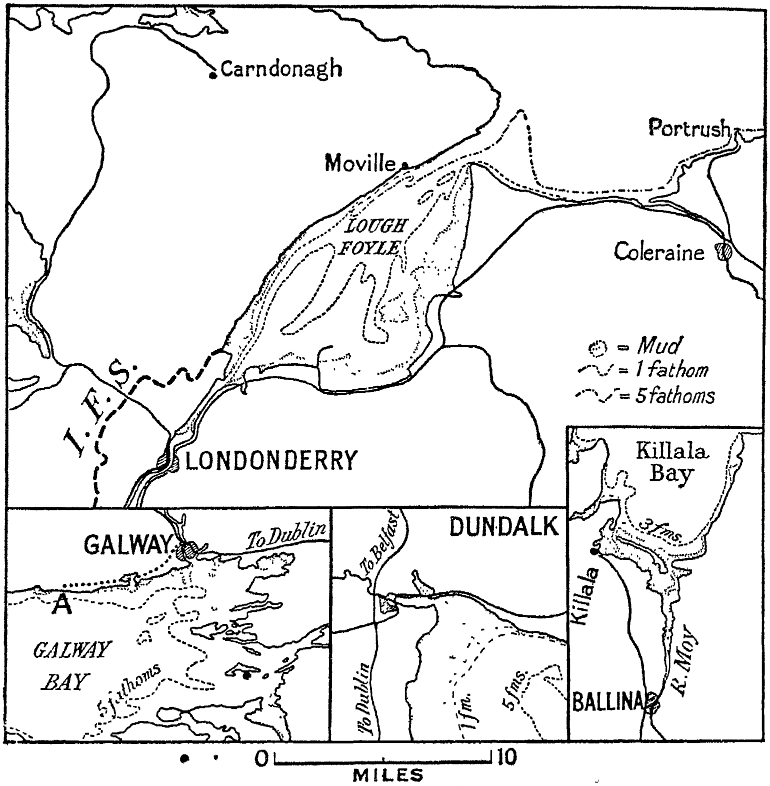

FIG. 288.—Sites of certain Irish ports. (*See also* Fig. 284.)

Galway : "A" is the proposed site for Atlantic terminal port, and the dotted line is the necessary rail link.

The hinterland includes the district served by the former Cork, Bandon, and South Coast, the West and South Clare, and the Tralee and Dingle Railways, and the main line from Rosslare to Cork and Limerick. The import trade is limited to small parcels traffic of high value, and coal, cement, and artificial manures, which do not travel long distances by rail. The export trade includes

[1] Rosslare to Fishguard 54 miles ; Dublin to Holyhead 62 miles ; Dublin to Liverpool 120 miles ; Kingstown to Holyhead 57 miles.

milk, cream, butter, eggs, live and dead poultry and fish—perishable commodities which are worth a long rail haul. Rosslare has been unsuccessful in developing a regular livestock trade.

The south coast of Ireland west of Dungarvan is characterised by drowned estuaries, within which are wide expanses of calm deep water. This is the region of sandstone hills, and limestone valleys denuded since the Armorican folding (see p. 55). As positions for ports those estuaries are good where entering streams link long fertile valleys with the sea, but their progressively westerly position places them at a disadvantage for trading with Great Britain. In regard to livestock, the main export of Ireland, their distance from the Severn, the Mersey, and the Clyde excludes them from the profitable export of fat cattle, and in regard to the main import of Ireland—coal, the higher sea freight brings them into competition with east-coast ports. Their export trade is more specialised, and manufactured livestock products take the place of livestock. This is the more noticeable according as the port lies further west.

The coast between Rosslare and Dungarvan, however, is neither of the eastern nor of the southern type. Here there are rugged features where the sea is attacking the Leinster Chain up the strike of the beds and where the harder rocks stand out as headlands sheltering deep bays. The combined Nore and Barrow joined by the longitudinal Suir from the west flow into one of these. The port of *Waterford* (Fig. 284) lies on the river Suir above the junction, and the key to its importance is its geographical position. Waterford was the chief cross-Channel port for Britain before the rise of Dublin.

This port is open to small ocean and cross-Channel vessels during certain hours on each tide. Quays line both sides of the river where discharge can be made direct by electrical cranes, but if there is insufficient water, timbered hulks or metal pontoons act as floating stages for the shipment of cargo. Since big boats have to lie on the rocky river bottom at low water, the larger grain ships avoid the port.

The city of Waterford, on the south side of the river, has no real connection with the port. Only goods for distribution in the city and along the short railway line from Waterford to Tramore are sent to the south shore. The traffic for the hinterland (Fig. 287) and the entire export trade are located on the north side, which is an excellent railway centre. The barge traffic to the city increases the cost of transport and enables Rosslare to compete in the city. The one-time extensive river traffic to Carrick and Clonmel has been almost wiped out by road transport, which also accounts for the serious decline in the coastwise traffic. River traffic, in barges and small vessels to New Ross and along the Barrow Navigation Canal, still exists.

The net register tonnage entering has declined since the beginning of the century.[1] In common with most of the larger Free State ports, however, the direct foreign shipping has increased with improved harbour depth and port facilities, and with the inception of the Free State. The decrease in the cross-Channel traffic dates from the War-time withdrawal and reduction of regular services to Liverpool and Bristol.[2] Until 1920, the port had a competitive advantage over Dublin, since no dues on goods were charged. This was short-sighted, as no funds were available for modern improvements. Rosslare and Dublin secured traffic before the belated improvements were completed.

Waterford is essentially a distributing port, as the small export trade is confined to livestock and small quantities of oats and timber. The decline in the export traffic is partly due to the competition of Rosslare and partly to the English tariff on cattle. In 1936, 89,894 animals were exported to the Mersey, the Clyde, and the Severn ports and Fishguard. Half were cattle (chiefly stores), and the remainder pigs and sheep.[3] The export of pigs is increasing. The import trade consists of coal (half the tonnage), maize, and artificial manures (imported in bulk), and flour, cement, sugar, and wheat. The greater amount of maize than wheat reflects the ratio between the livestock and the population in the hinterland.

The position of *Cork* (1926, population 78,490) (Fig. 284) on the River Lee enables the port to tap easily the small fertile valleys of the south-western counties, including the Golden Vale country. Vessels 460 feet long and drawing 26 feet can lie afloat at the quays, but must enter and leave on the tide. For the cross-Channel and coasting trade Cork[4] (17 feet L.W.O.S.T.) is an open port. The increased size of ocean vessels (especially grain) has led to the draining of the "sloblands" north of the Lee, and the deepening of the channel. The G.S. Railway sidings, with up-to-date equipment, will serve the reclaimed area. The new Ford works are on the south side of the river.

Cork is the second port in the Free State (Fig. 286), and the net register tonnage entering in 1935 was 729,878. The direct foreign shipping[5] has increased, but the cross-Channel shipping has decreased.[6] The import traffic has declined[7] since the pre-War

[1] Rosslare harbour was opened in 1904; Waterford, 1903, 506,143; Waterford, 1936, 416,860.

[2] Further decrease in cross-Channel trade commenced in 1932 as a result of I.F.S. Government policy—system of tariffs and licences.

[3] The embargo on live pigs and dead meat to Great Britain from the Continent gives Ireland opportunity to develop trade in fresh pork and bacon.

[4] Depth in river 75 years ago 3 feet.

[5] Report of Cork Harbour Commissioners.

[6] Suspension of certain cross-Channel services after the European War.

[7] Post-War labour troubles were acute, and in 1922 the destruction of Mallow bridge cut off part of the hinterland to the north for 13 months.

period, but is still greater than at the beginning of the century.[1] Coal forms half the imported tonnage, and maize, some of which is distributed coastwise, forms one-eleventh. The other commodities are wheat, fertilisers, wood, cement, flour, and iron goods. As in the case of Waterford, the large maize importation is for the live-stock industry. The import of wheat has declined steadily during the last few decades. Cork millers have suffered from the competition of English milled flour and the cost of the slow and primitive methods of discharging grain.[2] Cork has no inland water facilities, and the fact that Cork delivers goods by rail 10 miles to the north of Limerick (Fig. 287) is explained by the heavy cartage costs from Limerick port to the railway. Cork itself (1936, population 80,713) consumes 30 per cent. of its imports.

By reason of its more westerly position [3] Cork is less well-placed for perishable cross-Channel traffic. Thus the amount of cargo available for export is severely limited. Nevertheless Cork has an important export trade in perishable produce. The head of livestock exported is equal to that from Waterford, but as half is pigs and most of the cattle, stores, the traffic is less valuable. Oats are sent to England and France, and butter collected from an extensive area is shipped to Britain.

The lower harbour of Cork (36 feet L.W.O.S.T.) provides exceptional anchorage for liners.[4] *Cóbh* (Queenstown) on the south of Great Island has a quay (24 feet L.W.O.S.T.) adjacent to the railway station for the reception of mails and passengers. It has been suggested that the water at the quay should be deepened, so that trans-Atlantic liners of 20,000 net register tons can berth instead of employing tenders from the anchorage within and without the harbour.[5] Cóbh is essentially a packet station and has very little goods traffic. Since 1930 liners have been able to ship and discharge up to 25 tons net weight cargo from or to the United States or Canada, and up to 10 tons from or to any ports in Europe (excluding Great Britain and Ireland), without paying the higher rates usually collected from cargo vessels. This may foster traffic between the Free State and the North American Continent on the one hand, and Continental Europe on the other. Near Cóbh are islands, possible sites for a free port. Haulbowline has been suggested as being ideal. In Dublin a reclaimed area near the deep water Alexandra Basin has been suggested, but it would seem that the site suggested in lower Cork harbour is the better as it lies on a

[1] Population of Cork county, 1881, 486,300; 1936, 355,496.

[2] In 1920 grain merchants and Harbour Commissioners proposed to erect modern grain-discharging plant. Deadlock ensued between men's unions and merchants in regard to compensation of displaced employees.

[3] Cork is 284 miles from Liverpool.

[4] 1935, 3,003,250 net register tons.

[5] It is doubtful if the volume of passenger traffic is sufficient to recoup liners for berthing.

frequented trade route. There are also suitable terminal facilities for commercial air routes in connection with Atlantic shipping to British, French, and German air ports.

On the south-west coast *Kinsale* and *Baltimore* compete with Cork in "coarse" traffic within a limited area. Kinsale, a "barred" and tidal harbour, is important for the herring fishery carried on by Scottish trawlers and Scottish and Donegal girls. Kinsale is prevented from distributing other goods as the railway is one mile from the harbour. Above the port on the Bandon river is Kilmacsimon Pier where cargoes of coal, maize, and manure are landed from small cross-Channel boats. Oats are the only export. The hinterland is limited to Bandon town and the river valley.

Baltimore, sheltered by the extreme south-west headland, is rapidly declining. Sea freights are high as a result of geographical distance and the frequency of stormy weather. There are no discharging facilities, and only a little coal, flour, and bran are shipped inwards. Cured herrings (Scotch curers) form the only export. The mackerel fishing remains undeveloped in the absence of speedy and cheap transport (see Fig. 287).

East of Cork, at the mouth of the Blackwater, is *Youghal* (1 foot L.W.O.S.T.) distributing coal, cement, maize, and timber within a restricted area. The exports are sprats and salmon and occasional cargoes of oats. The small trade has dwindled since motor boats traded up the river to Cappoquin with coal and maize, and returned with oats.

The ports on the *West* coast of Ireland all suffer from their geographical position. Distance, and delay and risks to vessels in severe weather, result in higher sea freights. It is unfortunate that the longest navigable river system of Ireland should terminate in a long estuary leading westwards away from the densely-peopled countries of north-western Europe.

Limerick (Fig. 284) at the head of the Shannon estuary is a tidal port for all vessels, as there is only 4 feet L.W.O.S.T. in the river. The wet dock accommodates vessels drawing 22 feet, but vessels using the river quays above the dock take the ground at low tide. It has been proposed to deepen the channel and the existing dock for vessels drawing 24 feet, but the width and bends in the estuary would still limit their length to 450 feet, and therefore the time is not far distant when the port will be unable to take ocean-going vessels. A counter proposal is to develop Foynes, 36 miles from the open sea on the south side of the estuary. At present the larger grain ships lighten by means of a floating suction plant at the Beagh Castle anchorage (18 miles from Limerick). The greatest drawback to the ports is the absence of rail connection with the dock and river quays, and consequently the cost of carting heavy goods to the

railway limits the hinterland. It has been estimated that only a third of the imported tonnage [1] is distributed by rail beyond the city, and Nenagh 27 miles to the north-east of Limerick receives its coal *via* Dublin, 96 miles distant. The other imports are timber, cement, sugar, and flour. Although the port is the terminus of the Shannon Navigation system,[2] linked 53 miles to the north of Limerick with the Grand Canal and hence with Dublin, and further north with the little used Royal Canal, there is little direct interchange of goods between the port and the canal. Certain bridges are too low, and goods are transferred by road between the canal and the port. The missing rail link accounts for the development of Limerick independently of its hinterland (Fig. 284). Limerick is primarily a grain port and is the largest milling centre of Western Ireland. The tonnage of imports in 1925 was 303,548 tons,[3] whilst the export traffic was only 18,000 tons. Glasgow, the nearest market by sea, is 450 miles from Limerick—too far to ship livestock and perishable produce in competition with east-coast ports. The livestock from the Limerick area go in special trains to Dublin, and in 1925 only 3,423 were exported from the port of Limerick, with a small quantity of butter, eggs, potatoes, and timber. The port has maintained its traffic during post-War years.[4] Indeed, it has shown an increase, owing to the materials imported between 1925 and 1927 by Messrs. Siemens for the Shannon Electricity Scheme. It will be interesting to see whether in the future the opportunity for cheap power will lead to industrial development in the neighbourhood of the port.[5]

On the south shore of the Lower Shannon is *Foynes*, an open port [6] for all vessels, admirably placed for distributing by water. Goods can also be discharged direct into wagons for rail distribution at present limited to a 10 mile radius. The net register tonnage entering in 1903 was 353, and by 1928 was 33,121. The import of coal, oil, petrol, cement, and basic slag, has risen from 5,513 tons to 44,688 tons. Indeed, Foynes has become the distributing centre for petroleum and oil pumped direct from vessels to the storage depots. The export trade is very small, but increased in 1928 to 7,309 tons. The absence of regular cross-Channel services prevents the export of livestock, which centre on Limerick, by road and rail. A few local trawlers which market their fish in the immediate neighbourhood use the port, which is too far up the estuary to be of use for the deep sea fishing of Dingle and Valentia.

To the south, where the Shannon estuary meets the ocean, lie

[1] Includes coal and raw and manufactured grains.
[2] Distributed in 1925, 1,100 tons coal; 6,000 tons grain; 1,200 tons manure.
[3] 1927, 383,282 tons.
[4] Average, 1911/13, 173,843 net register tons; 1923/26, 188,039; 1927, 234,398.
[5] 1936. Up to the present practically no industrial development has resulted.
[6] 24 ft. L.W.O.S.T. 40 ft. H.W.O.S.T. See Fig. 287.

the ports of *Tralee* [1] and *Fenit* [1] on Tralee Bay (Fig. 287), from which a fertile limestone valley stretches eastward between high hills of Old Red Sandstone. Boats can unload at Fenit at all states of the tide [2] by means of cranes direct into railway wagons. From Fenit to Tralee, competing with the railway, is a ship canal (8 feet H.W.O.S.T.) and boats carrying 300-ton cargoes tranship salt, maize, bricks, slate, and coal. The weekly service to Liverpool carries out livestock and refrigerated goods and brings in general cargo. There is also a regular fortnightly service to London. A boat plies regularly between the port and Hamburg bringing sugar. Oil is also imported. The export trade in 1928 was 6,000 tons, and consisted of pit wood, maize, eggs, bacon, and butter. The tonnage of all imported goods amounted to 90,000 tons. Of late the import traffic has increased, for Fenit is geographically well placed for distributing in Kerry and the adjoining counties, and is potentially a bigger rival for Limerick than Foynes.

On the northern side of the Shannon estuary near the open sea is *Kilrush*, only suitable for small cross-Channel and coasting steamers trading from Limerick. Goods are landed at Cappagh Pier, one mile from the town, and at Merchants Quay in the town. The West Clare Railway serves both places and distributes coal, cement, sugar, flour, maize, manure, oils, and general groceries to stations in West Clare as far as Ennis. The steadily declining import traffic (chiefly from Limerick), of coal and oaten meal and occasional cargoes of manure, slag, and superphosphate (direct from the Continent), only amounts to 6,000 tons yearly, and the export coastwise of stone flags, livestock, and coal has almost vanished. Such livestock traffic as still exists goes by river steamer to Limerick and thence by ship to Glasgow. Kelp is also reshipped. The declining trade is due to the inadequate maintenance of facilities, and to the fact that it is more economical to redistribute goods imported in bulk from Limerick.

Midway along the west coast protected by the Aran Islands is Galway Bay, a deep indentation penetrating the limestone plain in the latitude of Dublin. Unfortunately, however, the approach to *Galway* Harbour (Fig. 288) itself is unfavourable to shipping; natural shelving takes place, and at a point close to the dock entrance, for a distance of slightly over 100 yards, a ridge of hard greenstone rock crosses the channel over which at low tide the depth of water is 2½ feet (17 feet H.W.O.S.T.). The largest vessel which can safely enter the docks at high tide is one drawing 16 feet. Sidings connect the docks with the Great Southern Railway, but are not near enough to the ship for the direct discharge of cargoes into railway wagons.

[1] Tralee and Fenit. Net register tonnage 1935, 68,263.
[2] 16 feet L.W.O.S.T.

Cargoes are discharged and carted by ships' gear and manual labour. The heavy cost of this helps to explain why Galway (1936, population 18,285) serves such a limited area.

The net register tonnage using the port in 1925 was 49,231, showing a steady decline compared with the opening of the century. Since 1926 trans-Atlantic vessels have anchored in the roadstead a mile or so off the port and transferred their passengers by tender. Galway is now a recognised port of call for emigrant and general passenger traffic inwards and outwards by Continental companies. For this reason, in 1936 the net register tonnage entering Galway was 621,775. In 1928, the imports were 57,000 tons, which included maize, flour, wheat, fertilisers, timber, cement, sugar, and coal. The exports are practically non-existent, amounting in 1928 to 6,000 tons, which include a certain amount of local timber, oats, and kelp. A great effort is being made to develop the export of livestock, and 9,000 head, principally sheep, were exported to Liverpool in 1928. Goods transhipped from Liverpool and Belfast form the bulk of the import trade. If the seaward approaches to the dock were improved, and vessels were able to use the port during more hours on each tide, and if modern discharging equipment with wagons alongside were installed, the port of Galway would enjoy a much larger share in the trade of its hinterland, and small overseas vessels could enter at high water and coasting vessels for a greater number of hours on each tide.

A great deal has been written [1] on the development of Galway harbour as a trans-Atlantic terminal [2] linked by express train service with Dublin, and from thence by train ferry to Holyhead and so to London. It has been pointed out that the crossing to Halifax could be accomplished in 3½ days, and that Galway has better communication with Belfast, Scotland, and Northern England than any other Atlantic terminal port in Britain and Ireland. Cork, indeed, is not so well placed for Northern Britain. The site of the proposed terminal is three miles to the west of Galway Town where the 10-fathom line is close to the shore, and where a breakwater could be built in deep water and provide complete shelter. Such a site (marked A on Fig. 288) would only necessitate the building of a short railway from the present one at Galway. Galway as a terminal has undoubted advantages, but the traffic would originate and terminate in Great Britain. British shipping companies already have enormous capital invested in terminal ports in Great Britain, and naturally are reluctant to transfer their interests outside the country.

Shut in by the mountains of Connemara and Mayo is Clew Bay.

[1] *Western Harbours of Ireland.* Sir John Purser Griffith. February 1923. *The Proposed National Harbour in Galway Bay* by Sir John Purser Griffith. April 1923. Dublin, University Press.

[2] No such scheme was placed before the Ports and Harbours Tribunal which visited Irish harbours in 1927.

Here, as in the case of Galway Bay, faulting probably accounts for the deep water close inshore, and submerged drumlins fill the head of the bay where limestone crops out at the surface (see p. 254). *Westport Quay* in the south-east, a mile from the town of Westport (1936, population 3,405) is approached by a tortuous channel. Occasionally in the past large vessels (draught more than 15½ feet) brought cargoes of maize, wheat, and flour, and lightened at an anchorage. All vessels lie on the mud at low tide. The railway comes only to the head of the Quay, and thus the direct discharge of cargoes from ship to wagon is impossible. Grain is unloaded by a pneumatic process to the elevator, the only modern equipment available. An added disadvantage of the port is that a hilly road a mile long connects the quay with the town. In 1935, the net register tonnage entering the port was 14,492. The import and the export trade have declined, and the outstanding feature is the disappearance, due to the war, of a large export trade [1] in livestock. This traffic now goes by rail to Dublin. Another unique feature of the port is the export (from a factory on the quay) of clog blocks amounting to 438 tons in 1928. The one-time export traffic in oats and oatmeal has now been replaced by importation from Scotland, but there is still a small export of timber and eggs. The total exports in 1928 were 1,098 tons and 239 head of stock. The imports are maize, wheat, and coal. The future of the port is bound up with the deepening of the channel to take boats drawing 20 feet at high tide, a costly process, as it means the removal of stiff boulder clay. The existing traffic between Westport and Liverpool is insufficient to justify the running of a second steamer for general goods and livestock. At present there seems to be no shipping company whose vessels touch at other ports on the west coast for such goods as might be offered from time to time. Westport, however, to secure any large trade in the hinterland, must have railway wagons and mechanical equipment along the quays.

On the south of Donegal Bay the limestone plain again approaches the coast. *Ballina* (Fig. 288) is on the northerly course of the river Moy, enclosed by the mountains of Mayo, the Curlew Hills and the Ox Mountains. To deepen the water over the bar the building of training walls [2] has been suggested, thus utilising the river scour and tidal flow for deepening the channel and fixing the position of the bar. The cost seems justifiable on account of the steady increase in the trade of the port. Other factors, however, will prevent a big volume of traffic :—the absence of rail connection, the restriction of vessels to the cross-Channel trade by the depth of the river, the absence of modern plant and methods for discharging cargo, the restriction caused by labour, preventing merchants

[1] 1913 : 35,000 cattle, sheep, and pigs exported to Liverpool and Glasgow.
[2] As built at many of the East Coast ports.

from using their own carts and lorries to fetch goods from the vessels, and the absence of any industry within the hinterland. The net register tonnage entering in 1936 was 23,610, and the imports amounted to 20,971 tons, comprising maize, flour, bran, timber, manures, cement, and coal. The very small general export traffic amounted to 1,634 tons, comprising eggs, garrigeen moss, timber, and mineral water, but 18,106 head of livestock were exported, including fat and store cattle, sheep, and lambs. The smaller head exported compared with the pre-War years is due to the fortnightly, instead of the weekly, sailings to Glasgow and Liverpool. On account of the heavy discharge and cartage costs and the fact that cargoes in bulk cannot be imported, Sligo and Limerick can rail flour, bran, and meal more cheaply to the hinterland of Ballina.

In the south-east of Donegal Bay is Sligo Bay, at the head of which is the port of *Sligo* (Fig. 287) the dominating port of north-west Ireland, and on the west coast second only to Limerick. It has excellent facilities for distributing goods to the east, west, and south. The port is open during restricted hours to cross-Channel steamers, and at high tide to small ocean-going vessels (depth in channel 22 feet H.W.O.S.T.). There is a weekly service to Liverpool, Glasgow, and Belmullett in County Mayo. The lightening of grain vessels is essential, and as this service, as well as the ultimate discharge of the cargo is performed by manual labour in a most wasteful and costly manner, the port suffers a big disadvantage. Deep-water berths are available as well as storage sheds for 2,000 tons of grain. The quays are connected by a harbour tramway, but this is too far from the vessel to allow direct discharge by the ship's derricks. The fixed hand-cranes are also unsuitable for discharging cargo. Coal which now requires two days by manual labour could be discharged in six hours if modern cranes were available; and costs could be further reduced if merchants were allowed to use their own lorries for taking goods ex-ship.

Sligo has steadily declined. The net register tonnage entering the port in 1935 was 66,783, and the imports amounted to 144,698 tons. These were principally coal and grain in bulk. The exports amounted to 4,770 tons, and included eggs and butter. In 1928, 31,314 head of livestock were exported, a record for post-War years. Killybegs and Ballyshannon, on the northern shore of the Bay of Donegal, are served by the Donegal Light Railway System which terminates at the latter port. Bundoran is served by a railway which runs northwards towards Ballyshannon and then inland without connecting with that town. If a light railway were constructed between Sligo and Bundoran, and a junction made between the light railway at Ballyshannon and the railway from Bundoran, there would be complete rail connection in the Free State between Donegal and the rest of the country. The hinterland of Sligo

would then include part of Donegal. The ports of Killybegs and Ballyshannon as well as other small centres in the county would be served by Sligo instead of Londonderry (Northern Ireland). If the depth of water over the bar and in the channel were greater, lightening could be dispensed with, and vessels could use the port for a larger number of hours on each tide ; but, though the superior rail facilities of the port might justify such a measure, the expense of maintenance by dredging would be prohibitive, and any advantage would be offset by the slow and primitive methods and excessive costs of handling cargoes which divert traffic to ports with better facilities and lower costs.

On the north-west of Donegal Bay are two ports (Fig. 287) on opposite coasts. *Ballyshannon*, on the southern side, is approached by a tortuous channel three miles in length leading from a shifting sandbar ($1\frac{3}{4}$–$4\frac{1}{4}$ feet L.W.O.S.T.). Thus the port is limited to cross-Channel vessels drawing less than 11 feet at high tide. Navigation presents difficulties. Ten small boats entered in 1928 [1] and the imports amounted to 1,187 tons, and included coal, flour, maize, and sugar. There are no exports.[2] Two small railway systems approach the port, but are unconnected with the quays, and this, combined with a small and thinly populated hinterland, discourages any improvement in a port with great physical disadvantages.

On the northern shore on a sheltered inlet is the small deep port of *Killybegs* (27 feet H.W.O.S.T.), consisting of a pier close to the town and the railway. Wagons can go alongside vessels. There is, however, no regular shipping to the port. In 1928, the net register tonnage entering was 1,581, and the imports, coal and flour, totalled 326 tons [3]—the smallest in any normal year. On the other hand, the export bunker coal amounted to 672 tons, the highest ever recorded. There is no local fish traffic. After the inception of the Free State the political boundary cut off the port of Londonderry from its exclusive hinterland, county Donegal, and Killybegs had a unique opportunity to develop at the expense of Londonderry. Local enterprise, however, has been lacking, and no effort has been made to develop this traffic. It is certain that an active export trade could be developed in butter, eggs, fish, kelp, and flagstones.

[1] No shipping entered during the War and the immediate post-War period, but activity recommenced in 1923.

[2] In 1928 were exported 21 tons of timber and 9 tons of iron.

[3] In 1933 1.953 tons.

CHAPTER XXXII

THE FOREIGN TRADE OF BRITAIN

In early times and during the Middle Ages the great feature of English trade was the export of raw materials and the import of manufactured articles. By far the most important of the exported raw materials was wool, but it was only one of several, the export duties levied on which furnished a large part of the revenue of the Crown. In order to collect this revenue, trade was regulated at an early date from the reign of Edward III, and particularly by the Ordinance of Edward III in 1353. This decreed that all the more important commodities which were named, and (formed thus the staple commodities) should be exported exclusively through certain English, Welsh, and Irish ports where the duties would be collected. The staple commodities enumerated are wool, sheepskins with the wool on, leather or hides, and tin; but on other occasions lead, cheese, butter, alum, tallow, and worsted are also mentioned; the last, however, infrequently. The ports specified include most of those of any significance on the east coast of England except Berwick-on-Tweed, also Southampton and Exeter on the South coast and Bristol on the west. Carmarthen was the sole staple port for Wales. In Ireland there were four: Dublin, Cork, Waterford, and Drogheda. The trade in the staple commodities was mainly in the hands of a privileged body known as the staplers who were, for the most part, foreigners. This was largely, it may be said, because Englishmen were liable to smaller dues than foreigners, and thereby the revenue of the king suffered. Amongst the foreigners engaged in the staple trade of England were many Italians, but members of the Hanseatic League were particularly important (see p. 627). English merchants therefore specialised in the trade in non-staple commodities. Their attempts at trading were adventurous, and hence they were known under the name of Merchant Adventurers and as such constituted themselves into organised companies. As English manufactures grew these became the most valuable commodities outside the staples. Woollen goods were the chief commodities whose sale abroad was pushed by the Adventurers. The Merchant Adventurers had a charter granted to them as early as 1404, and shortly afterwards the company

established its headquarters at Antwerp. Other companies followed, such as the Eastland, the Levant or Turkey, the East India, the Africa or Guinea, as well as the Hudson's Bay Company. The East India Co. obtained its first charter on December 31st, 1600, and retained a monopoly for trade with India until 1813, and with China until 1833, by which time the company had become a great territorial power. But in the fifteenth, sixteenth, and seventeenth centuries English manufactures gradually became the principal exports. Throughout the eighteenth century woollens were the most important, and every effort was made to check the rise of rivals. In the course of the eighteenth century cotton goods came to acquire a very considerable importance, and were sent in quantities from Bristol and Liverpool to West Africa to be exchanged for the slaves to be sold in the West Indies. The Industrial Revolution resulted in the placing of cotton manufactures first amongst our exports, a position which they have continued to hold ever since. To give an example of the position in the last century, in the years 1871–75 (average), cotton manufactures represented no less than 31·3 per cent. of the total exports, followed by iron and steel 12·9, and woollen manufactures about the same quantity. At that time coal and coke were only about 4·3 per cent. A table has here been included to show the changing importance of the principal exports of native produce and manufacture up to the pre-war years. It is seen that cotton manufactures occupied an important place, but one which tended to be steadily decreasing. The average for 1911–13 was 25·6 per cent. compared with 10·4 per cent. for iron and steel, 9·3 per cent. for coal and coke, and 8 per cent. for woollen manufactures, followed by machinery 7 per cent. (see p. 695).

The percentages referred to in the last paragraph relate to *values*. If tonnage is taken into consideration the significance of coal is at once apparent since it forms more than half the toal exports of the country. The huge export of coal has not only encouraged the shipbuilding industry, but has made it possible to offer very low rates for suitable return freights, *e.g.* iron ore.[1]

With the Industrial Revolution the import trade rapidly assumed the general features which it has to-day—showing an overwhelming importance in the imports of raw materials and foodstuffs, with raw cotton rivalling grain and flour for first place by value. The trade in the various commodities has been dealt with already. Something has been said of that trade so characteristic of the British Isles, the entrepôt trade, which results in a large import of material not intended for consumption in the country and in very large figures for re-exports. It has been further indicated that

[1] On some aspects of this subject, see Prof. A. J. Sargent, *Seaways of the Empire*, 2nd ed., 1930. For figures of tonnage of exports, see *Reports on the Balance of Trade*, League of Nations (now called *International Trade Statistics*).

nearly 60 per cent. of this particular trade is handled in London, the remaining 40 per cent. being shared by Liverpool (15), Southampton (10), and Dover (5). Most important amongst the commodities thus re-exported is wool. London remains one of the leading, if not the leading, wool market of the world, and the percentage of the total entrepôt trade (or re-exports) represented by wool has risen in some years to over 25 per cent. of the whole. Other leading articles in the same sphere are raw cotton, hides and skins, and rubber. Turning now to the post-1914 trade of the United Kingdom, when comparing this with the pre-1914 position, one must remember the separation of the statistics of Eire from those of the United Kingdom of Great Britain and Northern Ireland. Eire remains essentially an agricultural country with an export of its surplus of agricultural commodities and with a demand for manufactured goods. In this respect it is complementary to the United Kingdom.

Post-1914 Trade of the United Kingdom and Northern Ireland

It is opportune to repeat here the remark which was made in the preface to this volume. It is a dangerous fallacy, unfortunately much too prevalent to-day, to look upon the pre-1914 period as a

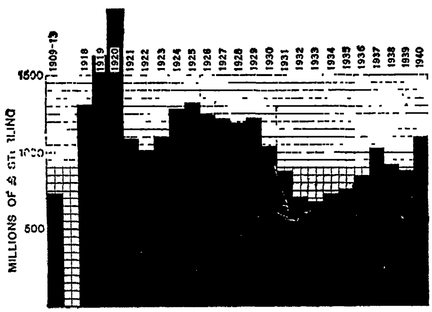

FIG. 289.—The fluctuations in the declared value of imports into the United Kingdom.

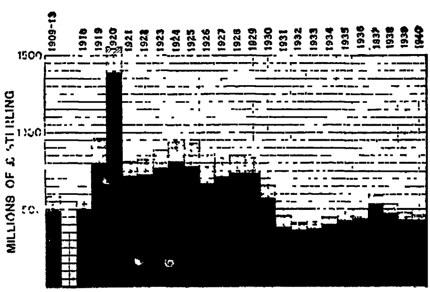

FIG. 290.—The fluctuations in the declared value of exports from the United Kingdom.

Exports of home origin shown in black; re-exports lined.

normal period and to regard the trade of this country in 1913 as being a standard or normal towards which we may look for a return. Such a view entirely ignores the course of normal progress and development in all parts of the world. British trade should take its right place in the modern world, but it is very unwise to look to

the pre-1914 period as a standard. In attempting to review the present trend of British trade the year 1924 affords a more convenient starting point. " Industry was then settling down after the fever and collapse which followed the end of the War. It was the first complete year after the separation of the Irish Free State statistics. It was the year of the third Census of Production; and it forms the basis for the Board of Trade Index of Production and index number of wholesale prices." [1]

The Volume of Trade.—" Trade is recorded by quantity and by value in various units, and comparison of the data for different years is affected by changes in average values and by alterations in the quality of the goods which continue to bear the same name. The aggregate value of British exports in 1931 was 51·4 per cent. less than the aggregate value of exports in 1924, but between the two years there was a fall of 28·2 per cent. in average values. The Board of Trade have for some years, accordingly, attempted to calculate the *volume* of trade passing in the several years after changes in value have been eliminated." The following two tables (taken from Macrosty's paper quoted above) show for retained imports and British exports: (*a*) declared values; (*b*) values recalculated on the 1924 basis; (*c*) the volume of trade as compared with 1924; and (*d*) average values as compared with 1924. The figures then show clearly that there was expanding trade for the six years 1924–29 followed by the depression from which we are only now recovering. The figures for 1936 have been added from other sources for comparison.

RETAINED IMPORTS, 1924–36

Particulars	1924	1925	1926	1927	1928	1929	1930	1931	1936
	(In Million £'s.)								
I. Food, drink, and tobacco:									
Declared	541	538	503	512	503	509	451	397	371
Revalued	541	532	528	553	548	566	573	619	—
	(In per cent. of 1924)								
Volume	100·0	98·3	97·5	102·4	101·1	104·7	105·8	114·3	—
Values	100·0	101·1	95·2	92·5	92·0	90·0	78·7	64·0	—
II. Raw materials and articles mainly unmanufactured:	(In Million £'s.)								
Declared	324	334	318	281	268	285	212	148	215
Revalued	324	346	386	366	328	365	327	305	—
	(In per cent. of 1924)								
Volume	100·0	106·7	119·0	113·0	101·3	112·8	101·0	94·1	—
Values	100·0	96·8	81·9	76·2	81·8	78·1	64·9	48·1	—

[1] H. W. Macrosty: "The Overseas Trade of the United Kingdom, 1924–1931," *Journ. Roy. Statistical Soc.*, XCV., 1932, 607–657. A most convenient summary of the subject. Gold and silver are excluded from the tables.

RETAINED IMPORTS, 1924–36—*continued*

Particulars	1924	1925	1926	1927	1928	1929	1930	1931	1936
III. Articles wholly or mainly manufactured:	(In Million £'s.)								
Declared	266	288	290	297	292	305	283	244	198
Revalued	266	298	318	342	345	360	361	370	—
	(In per cent. of 1924)								
Volume	100·0	112·2	119·3	128·4	129·7	135·3	135·6	139·1	—
Values	100·0	96·5	91·1	86·7	84·6	84·8	78·5	66·6	—
IV. Total (including animals, not for food, and parcel post):	(In million £'s.)								
Declared	1,137	1,167	1,116	1,095	1,075	1,111	958	798	849
Revalued	1,137	1,181	1,235	1,265	1,226	1,297	1,267	1,303	—
	(In per cent. of 1924)								
Volume	100·0	103·9	108·6	111·2	107·8	114·0	111·3	114·6	117·2
Values	100·0	98·8	90·4	86·6	87·7	85·7	75·6	61·2	69·2

Recent totals (declared): 1937, 1,028; 1938, 920; 1939, 886; 1940, 1,100.

BRITISH EXPORTS

Particulars	1924	1925	1926	1927	1928	1929	1930	1931	1936
I. Food, drink, and tobacco:	(In Million £'s.)								
Declared	57	55	50	52	54	56	48	36	36
Revalued	57	55	53	57	60	68	64	51	—
	(In per cent. of 1924)								
Volume	100·0	96·3	93·7	100·5	105·8	119·5	112·2	89·7	—
Values	100·0	100·2	94·9	91·4	90·0	81·8	75·6	67·0	—
II. Raw materials and articles mainly unmanufactured:	(In Million £'s.)								
Declared	106	84	47	76	70	79	64	47	51
Revalued	106	95	58	98	96	108	91	75	—
	(In per cent. of 1924)								
Volume	100·0	89·5	55·2	91·9	89·8	101·4	85·3	70·2	—
Values	100·0	88·6	79·4	78·1	73·4	73·1	70·2	63·2	—
III. Articles wholly or mainly manufactured:	(In Million £'s.)								
Declared	619	617	539	564	579	574	440	291	341
Revalued	619	628	583	646	668	676	543	403	—
	(In per cent. of 1924)								
Volume	100·0	101·5	94·2	104·4	107·9	109·3	87·7	65·2	—
Values	100·0	98·2	92·8	87·3	86·7	84·8	81·2	72·3	—
IV. Total (including animals, not for food, and parcel post):	(In Million £'s.)								
Declared	801	773	653	709	724	729	571	389	441
Revalued	801	795	712	819	838	868	711	541	—
	(In per cent. of 1924)								
Volume	100·0	99·3	88·9	102·3	104·7	108·3	88·7	67·8	82·6
Values	100·0	98·3	91·7	86·5	86·3	84·1	80·3	71·8	65·6

Recent totals (declared): 1937, 521; 1938, 471; 1939, 439; 1940, 413.
Recent totals of re-exports: 1936, 61; 1937, 75; 1938, 62; 1939, 46.

The Direction of Foreign Trade.—The outstanding general feature of the direction of British foreign trade is that it is practically world-wide. The following table in which 1935 figures are approximate only, analyses the general position :—

BRITISH OVERSEAS TRADE
(In percentages)

Countries from which goods were imported or to which goods were exported	Gross imports			British exports			Re-exports		
	1924	1930	1935	1924	1930	1935	1924	1930	1935
Self-Governing Dominions	19·01	18·67	24·21	23·55	24·59	28·8	15·43	17·78	14·7
India	6·17	4·89	5·45	11·31	9·28	8·9	0·80	1·48	1·1
Colonies, Possessions, and Protectorates .	5·03	5·56	7·98	6·81	9·64	11·3	2·66	4·32	4·0
Total: British countries .	30·21	29·12	37·64	41·67	43·51	48·00	18·89	23·58	19·82
Europe and Soviet Russia	31·74	39·41	34·87	30·79	32·27	32·7	57·41	56·30	59·6
Africa	4·04	2·23	2·00	3·74	3·74	3·8	} 6·14	7·19	7·5
Asia	3·83	3·96	3·15	8·52	5·70	3·6			
United States . . .	18·88	14·70	11·57	6·74	5·03	5·4	17·56	12·93	13·1
Rest of America . .	11·22	10·39	10·45	8·53	9·72	6·5	} See above, with Africa and Asia.		
Polynesia, etc. . . .	0·08	0·19	0·32	0·01	0·03	0·03			
Total: Foreign countries .	69·79	70·88	62·36	58·33	56·49	52·00	81·11	76·42	80·18
Total: All countries	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00
Total: All countries £'s million . . .	1,277	1,044	756	801	571	426	140	87	55

The first point to notice about this table is the large proportion of British exports which go to countries of the Empire—nearly 48 per cent. in 1935, though of our imports they provide rather less than 38 per cent. The most conspicuous changes in recent years include the smaller share of the imports provided by the United States due to a decrease in the quantities and values of cereals, cotton, and other raw materials and food-stuffs exported, largely owing to the increased consumption at home. The decline in the Indian percentage, largely due no doubt to the boycott of British goods, has been more than offset by the increased percentage of our exports taken by our colonies and possessions. The increased trade with the countries of Europe is interesting.

The United Kingdom and World Trade.—The table given below shows the proportion of the world trade which is shared by the United Kingdom, the United States, Germany, and France. To compare these figures it may be stated that in 1913 the United Kingdom held about 16 per cent. of the world's import trade and about 13 or 14 per cent. of the world's export trade. It will be noticed that the United Kingdom has taken a rather smaller share in world trade than in pre-war years, but it is difficult to make direct comparisons, and with reference to the United States the United Kingdom has probably more than held her own. The recovery of Germany and the rise to importance of some of the smaller countries since pre-war years affects the general position.

WORLD TRADE IN 1929–31

Country	Retained imports			Domestic exports		
	1929	1930	1931	1929	1930	1931
United Kingdom . . .	18·3 (15·4)	19·4	21·9	13·2 (10·9)	13·0	12·2
United States	14·9 (12·4)	12·7	11·8	19·3 (15·8)	17·7	15·3
Germany	10·8 (9·1)	10·3	9·0	12·0 (9·8)	13·4	14·7
France	7·7 (6·5)	8·6	9·3	7·3 (6·0)	7·8	7·7
Other countries . . .	48·3 (40·9)	49·0	48·0	48·2 (39·4)	48·1	50·1
All countries . . .	100·0 (84·3)	100 0	100·0	100·0 (81·9)	100·0	100·0
All countries £ Million . . .	6,078	4,938	3,641	5,506	4,395	3,188

Note.—These details refer to a number of countries whose trade statistics can be regarded as reliable and represent together about 83 per cent. of all world trade. The figures in brackets under 1929 are percentages referring to *total* world trade.

Trade in certain Industries.—The trade in certain special industries has been dealt with in the appropriate chapters. One or two points of recapitulation may be mentioned here.

(*a*) *The Textile Industries.*—Textile materials constituted some 52 per cent. of the value of retained imports of raw materials in 1924, and goods made from these materials contributed 37 per cent. of the value of all British exports and 48 per cent. of the value of all British manufactures exported. Even in 1931 textile materials were 39 per cent. of the value of retained imports of raw materials and textile goods were 24·6[1] per cent. of all exports. It is clear, therefore, that a recovery in our export trade depends largely on a recovery in the exports of textiles. In 1913 cotton yarns and manufactures alone formed nearly a quarter of the value of all our exports. The big decrease has been in the export of these goods to India and to a less extent to China, partly due to the competition of Indian and Japanese mills and partly to the increased poverty of the Indian peasant on account of the fall in value of his crops and partly to the political boycott and the recent imposition of heavy import duties. The woollen textile industry has suffered severely in its home trade from foreign competition to a much greater degree than is true of the home cotton trade. Largely owing to disorganisation in Russia the world's linen industry has suffered from dear and insufficient supplies of raw materials. Our imports have been small compared with pre-war years and our exports have declined seriously; prospects of recovery seem to be small. The production of artificial silk rose rapidly but fell in 1930 owing to overproduction.

(*b*) *The Metal Industries.*—Iron and steel, and goods made therefrom and from other metals, including machinery and vehicles, still account for about a quarter of the total of all British exports. Notwithstanding the large home production of iron and steel there is an important import, but it should be noted that the import is

[1] 19 per cent. in 1935.

mainly of crude iron and steel, the exports largely of finished products. Imported iron and steel secured a firm hold in the British markets during the industrial troubles of 1926 and 1927, but the hold has decreased. We cannot hope to go back to 1913 when we exported 1,124,000 tons of pig-iron ; but every effort is being made

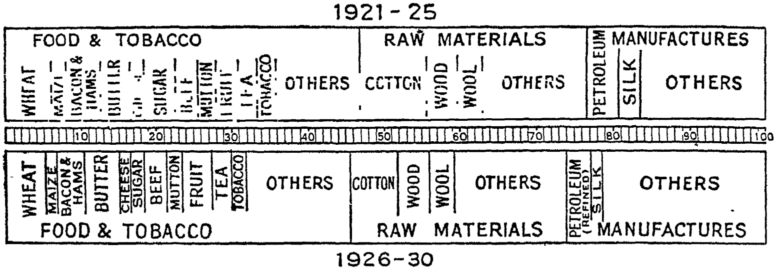

FIG. 291.—The Post-War Trade of the United Kingdom—Imports.
In 1939 : Food, etc., 45 per cent. ; Raw materials, 28 per cent. ; Manufactures, 27 per cent.

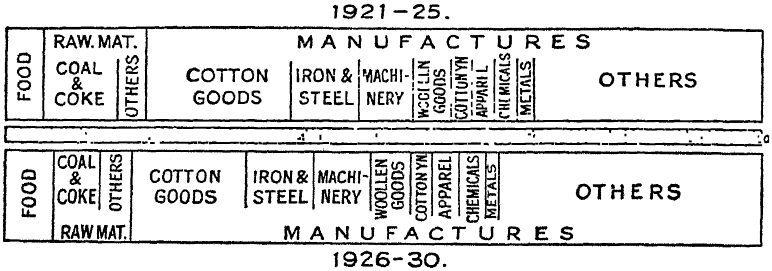

FIG. 292.—The Post-War Trade of the United Kingdom—Exports of home origin.
In 1939 : Food, 8 per cent. ; Raw materials, 13 per cent. ; Manufactures, 79 per cent.

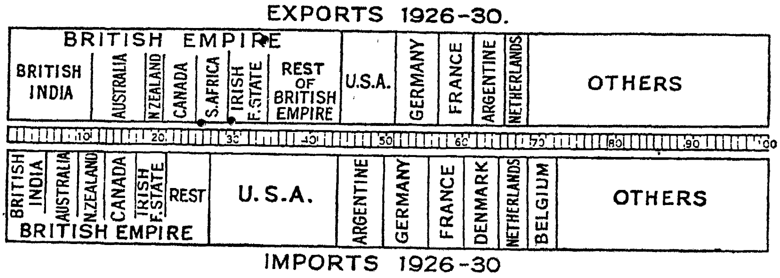

FIG. 293.—The Post-War Trade of the United Kingdom—Direction of Foreign Trade.

to maintain the export trade. It should be noted that the finer or smaller metal goods, including motor cars, clocks, and watches, photographic apparatus, cutlery, etc., are much affected by world prosperity and are influenced strongly by the slump.

(c) *The Chemical Industries.*—Some idea of the importance of the

import of chemical drugs, dyes, paints, and raw materials of the chemical industries may be gauged by saying that in 1924 the value represented more than half the value of the total *exports* of all home manufactures. On the other hand, Great Britain has a large export of heavy chemicals—fertilisers, such as ammonium sulphate, bleaching powder, and others.

The three groups of exports just considered—textiles, iron and steel and manufactures thereof, and heavy chemicals, represent over 80 per cent. of articles wholly or mainly manufactured. For details of imports and exports of other commodities reference should be made to the appropriate chapters and to the notes given under ports.

United Kingdom, Exports of Native Produce and Manufactures

Principal articles	Percentage of total value										Change per cent. 1924 on 1911–1913		
	1871–75	1881–85	1886–90	1891–95	1896–00	1901–05	1906–10	1911–13	1924	1926–30	Value	Quant.	1931–35
Cotton manufactures [1]	31·3	31·9[1]	30·2	29·2	26·9	27·2	26·0	25·6	24·9	19·2	+ 62	—	15·3
Yarn	*6·2*	*5·6*	*5·0*	*4·3*	*3·6*	*2·9*	*3·4*	*3·3*	*3·5*	*3·0*	+ 78	− 28	*2·7*
Thread	*0·6*	*1·0*	*1·2*	*1·3*	*1·4*	*1·2*	*1·1*	*0·8*	*0·9*	*0 9*	+ 79	—	*1·1*
Iron and steel [8]	12·9	11·4	11·1	9·4	10·4	10·0	10·8[2]	10·4	9·3[6]	8·3	—	− 19	6·9
Coal, coke, etc. [8]	4·3	4·3	5·5	7·3	9·0	9·5	9·8	9·3	9 8	6·4	+ 74	− 27	8·7
Woollen manufactures	—	—	—	10·7	9·7	8·5	8·4	8·0	8·5	7·2	+ 77	—	6·9
Tissues	*10·8*	*8·1*[1]	*8·6*	*7·6*	*6·3*	*5·7*	*5·5*	*5·4*	*5·2*	*4·6*	+ 59	+ 62	*3·8*
Yarn, woollen and worsted	*2·3*	*1·5*	*1·8*	*2·0*	*2·0*	*1·4*	*1·4*	*1·2*	*1·7*	*1·5*	+ 126	− 12	*1·6*
Yarn, alpaca, mohair, etc.	—	0·4	*0·5*	*0·6*	*0·7*	*0·6*	*0·6*	*0·5*	*0·3*	—	− 17	− 48	—
Tops	—	—	—	*0·3*	*0·6*	*0·7*	*0·8*	*0·7*	*0·8*	*0·7*	+ 92	− 2	*0·8*
Machinery and engines	3·6	5·1	5·6	6·4	7·3	6·9	7·6	7·0	5·6	7·4	+ 92	− 35	8·3
Chemicals, drugs, dyes	3·1	4·2	4·2	5·1	4·9	4·5	4·3	4·3	3·2	3·5	+ 21	—	4·7
Coal products, not dyes	*0·2*	*0·4*	*0·4*	*0·6*	*0·7*	*0·4*[3]	*0·4*	*0·5*	—	—	—	—	—
Linen yarn and manufactures	3·9	2·7	2·7	2·6	2·3	2·2	2·1	1·9	1·7	1·4	+ 42	—	1·5
Apparel and haberdashery	3·8	3·1	2·8	2·7	2·6	2·4	1·8	2·1	3·8[7]	3·7	+ 192	—	3·0
Leather manufactures, including boots	1·5	1·7	1·7	1·7	1·5	1·6	1·6	1·8	1·5	1·2	+ 44	—	0·9
Hardware, implements, etc.	—	2·1	1·9	1·6	1·6	1·6	1·3	1·4	1·1	—	+ 26	—	—
Cutlery and hardware	*1·9*	*1·5*	*1·2*	*0·9*	*0·8*	*0·7*	*0·6*	*0·5*	*0·3*	—	+ 1	—	—
Fish	0·5	0·8	0·7	0·8	1·0	1·2	1·2	1·4	1·1	1·1	+ 22	− 21	1·1
Earthenware and glass	—	—	—	1·2	1·2	1·1	1·0	1·0	1·6	1·9	+ 158	—	2·0
China	—	—	—	*0·8*	*0·7*	*0·6*	*0·6*	*0·6*	*0·8*	—	—	—	—
Copper and yellow metal	1·2	1·4	1·4	1·4	1·2	1·2	0·9	0·7	0·6	—	+ 53	− 20	—
Jute, yarn, and manufactures	0·7	1·1	1·1	1·2	1·0	0·9	0·8	0·7	0·7	—	+ 63	—	—
Spirits [4]	0·1	0·3	0·5	0·6	0·8	0·9	0·8	0·8	1·5	1·3	+ 186	—	1·6
Electrical goods, excluding machinery [5]	—	—	—	—	—	0·9	0·7	0·9	1·3	1·8	+ 142	—	1·9
Books	0·4	0·5	0·5	0·6	0·6	0·6	0·5	0·6	0·5	—	+ 51	+ 2	—
Silk yarn and manufactures	1·4	1·3	1·2	0·8	0·7	0·6	0·5	0·5	0·3	1·5	− 3	—	1·3[9]
Beer and ale [4]	0·9	0·7	0·7	0·7	0·7	0·6	0·5	0·4	0·2	—	− 40	− 60	—
Ships	—	—	—	—	—	—	—	—	0·7	1·8	—	—	1·1
Automobiles	—	—	—	—	—	—	—	—	—	2·4	—	—	3·3

[1] Large quantities of piece goods of mixed materials in which wool predominated were erroneously entered as cotton prior to 1884, annual value about £500,000.

[2] In 1906–10 "iron and steel" "includes tyres, wheels, axles" to the value of £1·08 million, also small amounts of old rails and telegraph wire.

[3] Peat and shale (naphtha, paraffin, etc.) excluded in 1901.

[4] Ex-ship stores.

[5] Telegraph wire was transferred in 1903 to "iron and steel."

[6] Iron, steel, and manufactures in 1924.

[7] Including boots and shoes.

[8] Low average 1926–30 due to the industrial troubles of 1926.

[9] Including rayon.

UNITED KINGDOM, GENERAL IMPORTS, EXCLUDING DIAMONDS AND BULLION AND SPECIE

Principal articles	Percentage of total value										Change per cent. 1924 on 1911–1913		
	1871–75	1881–85	1886–90	1891–95	1896–00	1901–05	1906–10	1911–13	1924	1926–30	Value	Quant.	1931–35
Grain and Flour	14·9	15·7	13·6	13·8	12·9	12·5	12·0	11·4	9·5	7·9	+ 46	− 44	8·7
Wheat	*7·2*	*7·0*	*5·5*	*5·6*	*4·9*	*5·5*	*6·3*	*5·9*	*5·4*	*6·9*	+ 61	+ 12	*4·1*
Maize	*2·1*	*2·2*	*2·1*	*2·0*	*2·3*	*2·1*	*1·9*	*1·7*	*1·3*	*1·9*	+ 34	− 14	*1·5*
Wheat meal and flour	*1·3*	*2·6*	*2·3*	*2·3*	*2·1*	*1·6*	*1·0*	*0·8*	*0·7*	*0·6*	+ 46	+ 3	*0·5*
Raw cotton	14·4	10·8	10·6	8·5	7·2	8·7	10·0	10·1	9·5	6·0	+ 64	− 32	4·6
Meat	3·6	6·3	6·6	7·5	8·7	9·1	7·9	7·1	8·2	9·2	+ 102	+ 33	12·2
Fresh beef and mutton	—	*0·8*	*1·2*	*1·9*	*2·4*	*2 9*	*3·0*	*3·2*	*4·1*	—	− 120	+ 31	*5·5*
Bacon and hams	*1·4*	*2·3*	*2·3*	*2·6*	*2·9*	*3·1*	*2·8*	*2·5*	*3·5*	*3·8*	+ 145	+ 67	*4·5*
Animals	*1·5*	*2·4*	*2·2*	*2·1*	*2·2*	*1·8*	*1·1*	*0·2*	*1·7*	*1·4*	+1183	+1730	*1·2*
Wool, sheep, alpaca, etc.	5·6	6·2	6·6	6·3	5·1	4·0	4·9	4·6	5·5	6·1	+ 109	− 4	4·9
Butter and margarine	2·1	2·9	3·2	3·9	4·0	4·3	4·1	3·8	4·3	4·2	+ 97	+ 22	5·2
Wood, total	4·6	4·1	4·0	4·0	5·0	4·6	4·1	4·0	4·0	3·7	+ 74	—	4·4
Sugar	5·6	5·6	4·6	4·7	3·7	3·2	3·3	3·4	3·5	2·0	+ 7	− 5	2·0
Refined	*1·0*	*1·1*	*1·7*	*2·4*	*2·2*	*2·0*	*1·9*	*1·8*	*1·3*	1·6	+ 19	− 33	—
Raw	*4·6*	*4·5*	*2·9*	*2·4*	*1·5*	*1·2*	*1·3*	*1·6*	*1·6*	0·4	+ 74	+ 19	—
Rubber	0·4	0·6	0·7	0·8	1·2	1·3	2·2	2·8	0·8	2·0	− 52	—	0·9
Silk yarn and manufactures	2·9	2·8	2·9	3·1	3·5	2·5	2·1	1·9	2·0	1·2	+ 81	—	0·6
Oil, seeds and nuts	2·1	2·1	1·9	1·7	1·4	1·6	1·9	2·0	4·1	1·6	+ 256	—	1·5
Hides, skins, and furs, raw	1·9	1·7	1·6	1·6	1·5	1·4	1·8	1·8	1·7	2·2	+ 59	—	2·1
Hides	*1·2*	*0·9*	*0·8*	*0·6*	*0·6*	*0·4*	*0·5*	*0·7*	*0·5*	—	+ 31	+ 6	—
Sheep and goatskins	*0·3*	*0·4*	*0·4*	*0·6*	*0·6*	*0·6*	*0·7*	*0·6*	*0·4*	—	+ 32	—	—
Tea	3·4	2·7	2·6	2·4	2·2	1·7	1·7	1·8	3·2	3·1	+ 205	+ 11	3·6
Chemicals	2·8	2·9	3·0	2·1	1·8	1·7	1·7	1·7	1·2	1·3	+ 19	—	1·0
Coal tar dyes	—	*0·1*	*0·1*	*0·1*	*0·2*	*0·2*	*0·3*	*0·2*	*0·1*	*0·4*	− 25	—	—
Fresh fruit and nuts	0·8	1·1	1·2	1·4	1·5	1·7	1·7	1·5	2·5	2·8	+ 194	—	4·0
Woollen yarn and manufactures to 1903	1·6	2·1	2·8	2·9	2·6	2·4	—	—	1·2	0·9	+ 47	—	0·6
Ex. apparel from 1904	—	—	—	—	—	2·1	1·6	1·4	—	1·6	—	—	1·3
Cotton yarn and manufactures	—	—	—	1·0	1·2	1·4	1·6	1·6	0·7	0·9	—	—	0·5
Leather	0·8	1·3	1·5	1·7	1·7	1·5	1·5	1·5	1·1	1·3	+ 26	− 33	1·1
Iron and steel manufactures } Machinery	—	—	1·1	1·0	1·2	1·5	1·3	1·8	1·7	2·3	—	+ 22	1·5
					0·6	0·8	0·8	0·9	0·8	1·5	+ 59	− 33	1·6
Eggs	0·6	0·7	0·8	0·9	1·0	1·2	1·1	1·2	1·5	1·5	+ 115	+ 2	1·2
Flax and hemp, raw and tow	2·1	1·4	1·4	1·2	1·1	1·3	1·1	1·1	0·8	—	+ 16	− 34	—
Cheese	1·1	1·2	1·1	1·2	1·2	1·2	1·1	1·0	1·1	1·2	+ 88	− 25	1·1
Tin	0·3	0·6	0·7	0·6	0·9	0·9	1·1	1·2	0·3	0·8	− 54	—	} 1·8
Copper	0·9	0·6	0·7	0·5	0·8	0·9	1·1	0·9	0·8	—	+ 48	—	
Iron ores	0·2	0·6	0·7	0·7	1·0	0·9	0·9	0·9	0·7	0·4	+ 37	− 13	
Petroleum	—	—	—	—	—	—	—	—	—	3·2	—	—	4·2

The Foreign Trade of Eire

The diagrams illustrating the foreign trade of Eire (Figs. 282–3) show at once the overwhelming importance of the exports of agricultural origin and stress the fact that more than a quarter of the value of the whole exports of Eire is normally formed by live cattle. In this respect Ireland is unique, and to maintain this export it is clear that there must be an importing country near at hand. Actually, of course, the export of live cattle has been largely store cattle for fattening in the lowlands of England or of fat cattle ready for slaughtering when they reach Liverpool. The establish-

ment in Ireland of local works of the Ford Company at Cork has not only affected the character of motor vehicles and tractors found throughout the country—a matter of great importance to an agricultural country—but is also indicated by the development of an export, which started in 1929, of tractors. No other manufactured goods, unless one regards beer under this category (or butter and other agricultural produce) reach the value of a quarter of a million annually. The imports into Ireland bring out the dependence of the country on foreign supplies of coal and practically all manufactured goods as well as the dependence of the country—as is true also of the United Kingdom—on foreign supplies of the essential foodstuffs. As we have shown elsewhere in this book, wheat used to be grown over large areas in Ireland, but one must admit that the geographical conditions of the country are quite unsuited to the production of this crop, and it cannot be grown economically in competition with other countries of the world where the geographical conditions are more suitable, as in Canada or Australia, but production is now encouraged by Government.

There are, then, three special aspects of the foreign trade of Eire worthy of notice. In the first place, Eire sells various commodities, particularly foodstuffs which are not produced in sufficient quantity in Britain, to that country; whilst Great Britain supplies manufactured articles that cannot be made in Ireland. It is not surprising, therefore, to see that Eire in 1929 sold 93 per cent. of all its exports to Great Britain and Northern Ireland and purchased 78 per cent. of all its requirements from the same sources.[1]

The second point is that in the supply of agricultural products to Britain, and indeed to any other country which may serve as a market for these goods, Eire has a great rival in Denmark. In 1938 nearly 60 per cent. of all Denmark's exports went to Britain. But in the third place the contrast with Denmark is interesting. Whereas Ireland's leading export is live cattle, Denmark specialises in butter and bacon. An interesting geographical comparison can be made between Eire and Denmark, both countries hampered to some extent by natural geographical conditions—Ireland by too much rainfall and a poor drainage, and Denmark by a poor soil. Denmark has achieved success in her dairy-farming industry largely as the result of carefully planned co-operation amongst the small farmers. Ireland is treading the same path as far as her dairy-farming industry in the south-west is concerned. But Ireland has, on the whole, a long way to go before she achieves the economic prosperity of Denmark, though no geographical reasons really exist why she should not make such progress.

[1] In 1930 these percentages were 91, 80; in 1931, 96, 81; in 1932, 96, 71; in 1933, 94, 70; in 1934, 94, 67; in 1935, 92, 54.

CHAPTER XXXIII

THE NATIONAL CAPITAL—ITS GROWTH AND DISTRIBUTION

By Lord Stamp, G.B.E., D.Sc., LL.D., F.B.A.

The foregoing descriptions of industrial and commercial activities in the British Isles and their geographical distribution may not convey a full idea of their relative importance or magnitude, nor of the respective rates at which they have grown and how each stands related to the size of the whole economic organisation. There are no precise tests by which these aspects can be shown in a manner satisfactory to all questioners. For example, the relative "importance" is not exhibited properly by the statistics of foreign trade (cf. Chapter XXXII), inasmuch as the proportions of the several branches of economic activity which are represented in exports and in home consumption respectively are very different. To many people relative importance might be measured better by the number of people employed in each industry, and an attempt is made to show this through the details of the occupational census every decade (see Chapter XXIV). This, however, is not free from ambiguity and difficulty inasmuch as such occupations as clerks, engineers, or carpenters run throughout the great industries and are common factors. Moreover, the numbers of people employed on relatively low grade work may be partly and functionally related to the amount of capital employed; thus an industry with a large amount of fixed capital may for that very reason employ fewer men than others, as in the chemical industry, and an industry could not be said to be getting lower in the scale of "importance" merely because it was so successful and progressive as to attract a large investment of new capital without adding to the number of men employed at the same time, as compared with another industry which was less advanced industrially. Moreover, per capita employment as a measure in itself could not stop short at the men directly employed, for the industry that might be in process of taking fewer men directly might be responsible for a growing addition to employment in building and engineering industries, in providing and maintaining its capital equipment, and in the transport and distributive industries in handling the product. A more satisfactory measure of relative importance is found in the "total net output"

of the several industries classified under the Census of Production, because out of the net output has to come the return of both labour and capital; it is the value "added" to the cost of raw material by the industry when it passes the product on to the next industry or to the distributor, and that added value is distributed to the people, workers and shareholders, who have produced it. The actual profits made in each industry are not known, although those few who have experience of the confidential statistics of profits shown for income tax purposes are able to get a shrewd idea of their relative importance; but profits are not an ideal test of relative importance, for special technical reasons. From time to time, estimates have been made of the *National Capital*,[1] and this subject has a literature and technical apparatus of its own. Broadly speaking, a particular business has a "capital value" at which it is worth to be bought and sold as a whole, and as a going concern, without particular regard to the amount of money sunk in it in the past, and if these values for all the businesses in an industry are aggregated we have a "capital value" of that industry, although as a matter of strict fact, no one could or would buy a whole industry, and the "value" of one part of it is affected by what is done with another part. In the same way, the value of all the industries may be added together, giving a "national capital," and although in many senses this is only a "notional" capital it does at any rate serve to give aggregates which, apart from larger changes in the value of money, are comparable over periods of time, and in which, even *without* regard to changes in the value of money, we may observe changes in the different parts.

In my estimate for 1928 the following were the chief items :—

	£'s-million
Real property—Buildings	4,500
Land	950
Farmers' Capital	450
Profits and Interest	16,170
Profits below Income Tax level	475
Furniture and moveable property	1,500
Government and local property	900
	24,945
Less belonging to people abroad	500
Gross wealth	24,445
Deduct Debt charges	6,400
Net wealth	18,045

Reference to the official statistics showed that the profits for the year following, the last year reasonably normal before the great

[1] See Lord Stamp: *British Incomes and Property*, which gives a summary of such estimates, and also *The National Capital*, 1937.

depression set in, was about five per cent. greater than these, so the aim of this analysis is towards a rather higher total capital.

The reader must refer to the original address if he wishes to understand all the differences in the significance of the gross as compared with net wealth, and of the degree of statistical accuracy attaching to the several parts. For the purposes of this chapter, I shall be concerned with the net figure £18,045 million plus an addition to bring up to the following year, say, £18,950, of which £10,400 millions, or 55 per cent. represents industrial and commercial activities, and £5,500 millions real property, and £450 farmers' capital. Although the total is actually made up in greater detail in the address, it is not very useful for the purposes of this chapter, because it includes the value of income derived from businesses situated abroad; and the capital values of mines, oil fields, etc., situated abroad, but owned in this country, have no geographical relation to the businesses or properties actually situated here. From the best of the detailed information in my possession, and with some reserve on the question of statistical exactness, the following detailed industrial totals are suggested as being appropriate sections of the total valuation :—

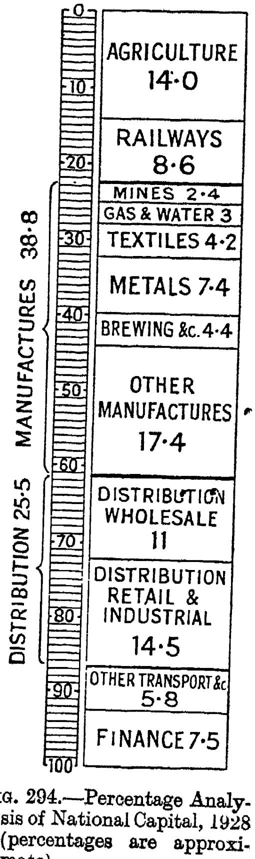

FIG. 294.—Percentage Analysis of National Capital, 1928 (percentages are approximate).

	£'s-million	
Agriculture (owners and farmers)	1,400	
Railways	860	2,260
Mines		240
Gas and water		300
Cotton	130	
Wool	100	
Other textiles	190	420
Iron and steel	420	
Small ferrous industries	240	
Copper, etc.	80	740
Brewing, etc.	440	
Tobacco	135	
Sugar	250	
Soap, chemicals, etc.	275	
Leather, etc.	275	
Paper, etc.	320	
Timber and building	325	
China	160	2,180
Distribution and wholesale		1,100
retail		1,450
Transport (shipping, trams, electric power)		580
Banking and finance		750
		10,020

The relative importance of manufacturing, transport and distributive activities has shifted somewhat during the past few decades. Comparisons of actual aggregate capital values are not very satisfactory, because of changes in the value of money : of recent years the totals would be rather over double the pre-war totals, and three and a quarter times the totals of forty years ago. A better approach is a broad comparison of the percentages of each section at each

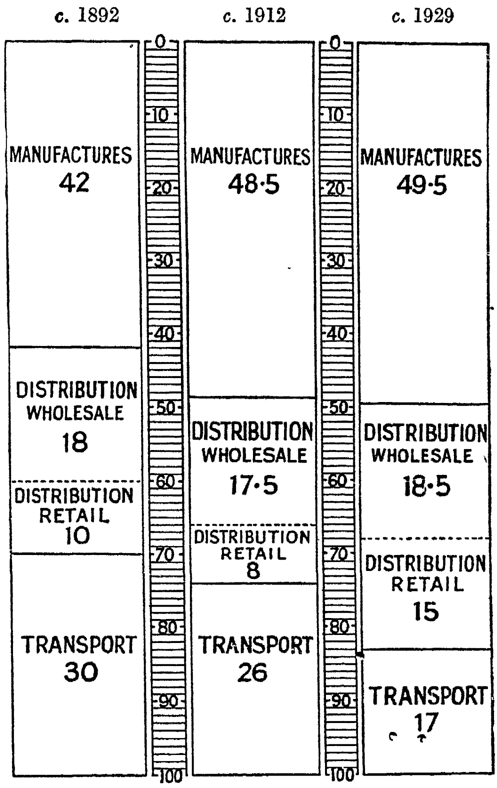

FIG. 295.—Comparative percentage of Capital engaged in different activities at different periods.

period, which is attempted in Fig. 295. From this it will be seen that transport, despite the huge growth of road traffic, is less important relatively, but distribution shows a striking advance.

The relative proportions of the different manufacturing groups have also changed a little during the same period, and, with even wider reservations on the question of statistical exactness, the comparisons are given in Fig. 296. From this it will be seen that the extractive industries are less in relative importance, reflecting, too,

the depressed state of the coal industry, and, as might be expected, the miscellaneous industries have gained ground on the large staple industries.

It must be appreciated that the foregoing computations represent in no way the actual capital put into the respective industries in the past, and depression in the coal or textile industries reduces the capital value as "going concerns" although the past capital

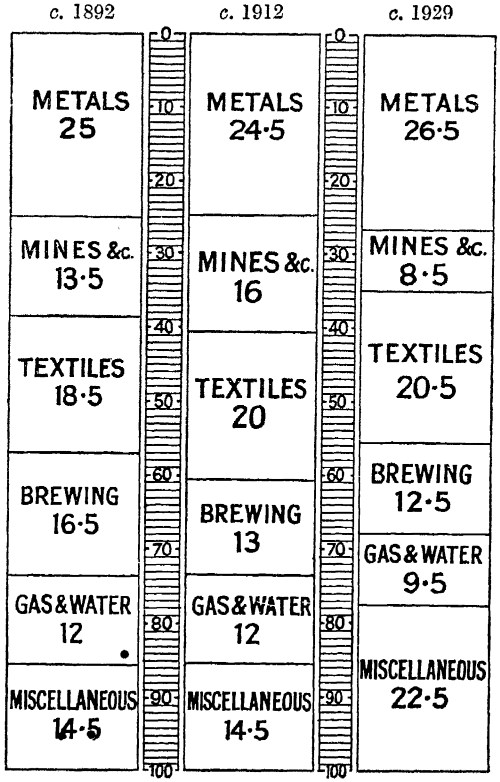

FIG. 296.—Relative importance of manufacturing industries at different dates.

involved remains unchanged, if we are not concerned whether it is "dead" or "alive."

But the method does tend to reflect the true relative vigour of industries. The Census of Production figures, inasmuch as the "net value" includes the fund available for wages, as well as profits, gives over a limited range, a wider view of relative importance. A rough comparison may be made between 1907, 1924, and 1930 :—

	1907	1924	1930
Mines and quarries	119·5	226·2	153·5
Iron and steel, engineering and ship-building	153·1	298·3	304·5
Other metal industries	11·9	25·1	22·8
Textiles	94·3	210·6	134·8
Clothing trades	47·7	74·8	70·9
Food, drink, and tobacco	89·5	169·8	179·0
Chemical and allied trades	21·6	65·5	70·1
Paper, printing, and stationery	33·6	92	98·8
Leather, etc.	8·6	11·6	9·9
Timber	21·4	26·7	28·8
Clay, stone, brick, etc.	60·4	112·2	119·1
Total in £ million	661·6	1,312·8	1,192·2

It will be seen from this that the percentages in the main groups were roughly :—

Mines and quarries	18·0	17·0	13·0
Engineering and metals	25·0	25·0	27·5
Textiles	14·5	16·0	11·5
Other manufactures	42·5	42·0	48·0
	100·0	100·0	100·0

Fig. 297 shows this graphically, taking the mean between 1924 and 1930.

It is clear from this table that, as in the case of the test of capital values, the mining and textile industries have increased much less than the average, and engineering and miscellaneous trades much more than the general average. The range between 1907 and the mean of 1924 and 1930 by the Census is an average increase of 88 per cent., and as between " *c.* 1912 " and " *c.* 1929 " on the capital tests, 115 per cent. (But if the census is taken to 1924 only the average increase is 100 per cent.)

Within the group of miscellaneous industries food and drink production showed a mean increase of 100 per cent. in the Census ; clothing and leather and timber and building increased less, but chemicals and paper increased more than the average. The capital values between " pre-war " and " now " show that food and drink production increased rather less than the average, chemicals and paper more than the average.

Greater precision in the comparisons of relative importance through capital values and other tests is unfortunately not possible,

because over a considerable period there is a material change, either in the statistical measurements where they are available, or

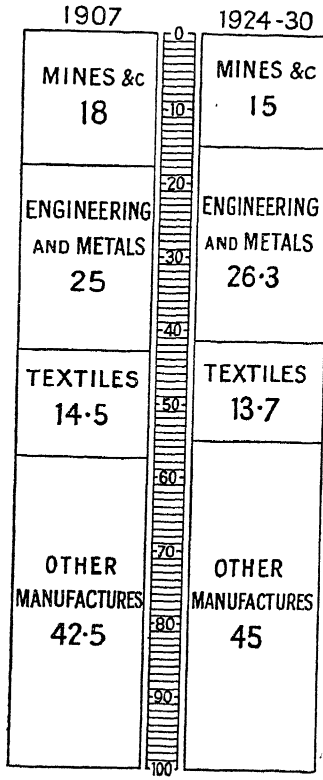

FIG. 297.—Relative importance of industries according to the results of the Censuses of Production.

in the character of the industries, while changes in the value of money and the rates of interest affect certain sections, such as agriculture, very differently.

INDEX

The numbers in heavy type refer to a more important mention of the subject of reference. Conventional abbreviations are used, as *e.g.* Rly. = Railway, R. = River, etc.

THE END